DOCUMENT RESUME

ED 104 315 | HE 006 453

TITLE	Degree Credit Enrollment. University of Maine. Fall 1970 - Fall 1974. Institutional Research Memorandum No. 13.
INSTITUTION	Maine Univ., Bangor. Office of Institutional Research.
PUB DATE	1 Dec 74
NOTE	14p.
EDRS PRICE	MF-$0.76 HC-$1.58 PLUS POSTAGE
DESCRIPTORS	Credit Courses; Degrees (Titles); *Enrollment; *Enrollment Rate; *Higher Education; *State Universities; *Statistical Data
IDENTIFIERS	*University of Maine

ABSTRACT

The data in this summary portray full-time, part-time, and total headcount enrollment for each campus and the entire university of Maine for the years from 1970 to 1974. Full-time equivalent (FTE) enrollment is also shown. For fall 1974, two different FTE enrollments are shown. The first is comparable to the previous years, the second FTE figure reflects the new method for equating part-time students to full-time students on the basis of student credit hours generated. Both FTE figures are shown so that the difference created by a new methodology may be noted. From fall 1973 to fall 1974, headcount enrollment increased by 2 percent. Part-time enrollment increased by 1 percent and full-time enrollment by 1.5 percent. FTE enrollment, using a similar method both years, increased by 2.4 percent. Regular day-time enrollment increased by 5.3 percent (headcount) while continuing education enrollment declined by 5 percent. (Author/PG)

HE 006 453

OFFICE OF THE CHANCELLOR

UNIVERSITY OF MAINE

INSTITUTIONAL RESEARCH
MEMORANDUM No. 13

December 1, 1974

DEGREE CREDIT ENROLLMENT

University of Maine

Fall 1970 - Fall 1974

HE 006 453

Office of Institutional Research
107 Maine Avenue
Bangor, Maine 04401
207-947-0336

THE OFFICE OF FINANCIAL PLANNING OF THE UNIVERSITY OF MAINE PUBLISHED INFORMATION SHEET #9, JUNE 13, 1973 SUMMARIZING DEGREE CREDIT ENROLLMENT AT EACH CAMPUS FOR EACH YEAR FROM FALL 1965 THROUGH FALL 1972.

INSTITUTIONAL RESEARCH MEMO #7, JANUARY 29, 1974, PROVIDED SIMILAR DATA FOR THE 5-YEAR PERIOD FROM FALL 1969 - FALL 1973.

THIS MEMO SHOWS DATA FOR THE 5-YEAR PERIOD FROM FALL 1970 - FALL 1974. A MORE DETAILED REPORT AND ANALYSIS WILL BE FORTHCOMING.

DEGREE CREDIT ENROLLMENT
University of Maine
Fall 1970 - Fall 1974

The data in this summary portray full-time, part-time and total headcount enrollment for each campus and the entire University of Maine for the years from 197. to 1974. Full-time equivalent (FTE) enrollment is also shown.

For Fall 1974, two different FTE enrollments are shown. The first, which is comparable to the previous years, is computed as follows:

1. Undergraduate students

   1 full-time student = 1 FTE student
   1 part-time student = .5 FTE student

2. Graduate students

   regular day students = 1 FTE student
   CED students are equated in the same manner as undergraduate students

The second FTE figure which is in parenthesis reflects a new method for equating part-time students to full-time students on the basis of student credit hours generated, as follows:

1. Undergraduate level programs:

   $$\frac{\text{Total student credit hours generated}}{15} = 1 \text{ FTE student}$$

2. Graduate level programs:

   $$\frac{\text{Total student credit hours generated}}{9} = 1 \text{ FTE student}$$

Both FTE figures are being shown so that the difference created by a new methodology may be noted.

(over)

From Fall 1973 to Fall 1974, headcount enrollment increased by 2%. Part-time enrollment increased by 1% and full-time enrollment by 1.5%. FTE enrollment, using a similar method both years, increased by 2.4%.

Regular day-time enrollment increased by 5.3% (headcount) while Continuing Education enrollment declined by 5%.

The changes vary from campus to campus.

Table 1. Enrollment, University of Maine, All Campuses, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	14,732	15,340	15,659	15,965	16,068	
Part-time	623	400	636	1,126	1,936	
Headcount	15,355	15,740	16,295	17,092	18,004	
FTE	15,043.5	15,540.0	15,977.0	16,526.0	17,157.0	
II. Continuing Education						
Full-time	273	772	363	547*	686	
Part-time	6,116	5,915	7,187	7,555	7,006	
Headcount	6,389	6,687	7,550	8,102*	7,692	
FTE	3,331.0	3,729.5	3,956.5	4,324.5**	4,189.0	
III. Total						
Full-time	15,005	16,112	16,022	16,513*	16,754	
Part-time	6,739	6,315	7,823	8,681	8,942	
Headcount	21,744	22,427	23,845	25,194*	25,696	
FTE	18,374.5	19,269.5	19,933.5	20,850.0**	21,346	(20,074.26)***
IV. Distribution by Residence						
In-state	19,467	20,171	21,402	22,420	22,577	
Non-resident	2,227	2,256	2,443	2,774	3,119	
Total	21,744	22,427	23,845	25,194	25,696	

* Figure has been decreased by 44 students who were enrolled in non-credit courses.
** Figure has been decreased by 22 FTE students who were enrolled in non-credit courses.
*** Figure in parenthesis shows FTE computed according to new formula. See text.

Table 2. Enrollment, University of Maine at Augusta, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	416	528	545	543	664	
Part-time	27	15	33	65	104	
Headcount	443	543	578	608	768	
FTE	429.5	535.5	561.5	575.5	716.0	
II. Continuing Education						
Full-time	183	286	146	176	130	
Part-time	825	1,500	1,762	1,760	1,697	
Headcount	1,008	1,786	1,908	1,936	1,827	
FTE	595.5	1,036.0	1,027.0	1,056.0	978.5	
III. Total						
Full-time	599	814	691	791	794	
Part-time	852	1,515	1,795	1,825	1,801	
Headcount	1,451	2,329	2,486	2,544	2,595	
FTE	1,025.0	1,571.5	1,588.5	1,631.5	1,694.5	(1,304.55)*
IV. Distribution by Residence						
In-state	1,451	2,329	2,482	2,539	2,574	
Non-resident	0	0	4	5	21	
Total	1,451	2,329	2,486	2,544	2,595	

* Figure in parenthesis shows FTE computed according to new formula. See text.

Table 3. Enrollment, University of Maine at Farmington, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	1,268	1,315	1,382	1,470	1,519	
Part-time	34	19	10	13	0	
Headcount	1,302	1,334	1,392	1,483	1,519	
FTE	1,285.0	1,324.5	1,387.0	1,476.5	1,519.0	
II. Continuing Education						
Full-time	0	10	64	72	47	
Part-time	198	276	253	392	332	
Headcount	198	286	317	464	379	
FTE	99.0	148.0	190.5	268.0	213.0	
III. Total						
Full-time	1,268	1,325	1,446	1,542	1,566	
Part-time	232	295	263	405	332	
Headcount	1,500	1,620	1,709	1,947	1,898	
FTE	1,384.0	1,472.5	1,577.5	1,744.5	1,732	(1,691.07)*
IV. Distribution by Residence						
In-state	1,407	1,525	1,576	1,780	1,704	
Non-resident	93	95	133	167	194	
Total	1,500	1,620	1,709	1,947	1,898	

* Figure in parenthesis shows FTE computed according to new formula. See text.

Table 4. Enrollment, University of Maine at Fort Kent, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	365	384	420	456	377	
Part-time	3	5	13	6	13	
Headcount	368	389	433	462	390	
FTE	366.5	386.5	426.5	459.0	383.5	
II. Continuing Education						
Full-time	4	1	2	8	7	
Part time	82	138	180	99	123	
Headcount	86	139	182	107	130	
FTE	45.0	70.0	92.0	57.5	68.5	
III. Total						
Full-time	369	385	422	464	384	
Part-time	85	143	193	105	136	
Headcount	454	528	615	569	520	
FTE	411.5	456.5	518.5	516.5	452.0	(450.8)*
IV. Distribution by Residence						
In-state	439	496	605	543	450	
Non-resident	15	32	10	26	70	
Total	454	528	615	569	520	

* Figure in parenthesis shows FTE computed according to new formula. See text.

Table 5. Enrollment, University of Maine at Machias, Fall 1970 – Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	555	535	492	480	476	
Part-time	1	11	36	60	36	
Headcount	556	546	528	540	512	
FTE	555.5	540.5	510.0	510.0	494.0	
II. Continuing Education						
Full-time	0	0	0	0	0	
Part-time	16	91	81	158*	126	
Headcount	16	91	81	158*	126	
FTE	8.0	45.5	40.5	79.0**	63.0	
III. Total						
Full-time	555	535	492	480	476	
Part-time	17	102	117	218*	162	
Headcount	572	637	609	698*	638	
FTE	563.5	586.0	550.5	589.0**	557.0	(546.3)***
IV. Distribution by Residence						
In-state	553	621	592	687	609	
Non-resident	19	16	17	11	29	
Total	572	637	609	698	638	

* Figure has been decreased by 44 students who were enrolled in non-credit courses.
** Figure has been decreased by 22 FTE students who were enrolled in non-credit courses.
*** Figure in parenthesis shows FTE computed according to new formula. See text.

Table 6. Enrollments, University of Maine at Orono, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	8,135	8,304	8,302	8,451	8,486	
Part-time	411	218	423	416	802	
Headcount	8,546	8,522	8,725	8,867	9,288	
FTE	8,340.5	8,413.0	8,513.5	8,659.0	9,008.5	
II. Continuing Education*						
Full-time	0	152	109	88	103	
Part-time	2,297	1,228	1,205	1,254	1,185	
Headcount	2,297	1,380	1,314	1,342	1,288	
FTE	1,148.5	766.0	711.5	715	695.5	
III. Total						
Full-time	8,135	8,456	8,411	8,539	8,589	
Part-time	2,708	1,446	1,628	1,670	1,987	
Headcount	10,843	9,902	10,039	10,209	10,576	
FTE	9,489.0	9,179.0	9,225.0	9,374.0	9,704.0	(9,553.11)**
IV. Distribution by Residence						
In-state	8,957	8,133	8,236	8,172	8,305	
Non-resident	1,886	1,769	1,803	2,037	2,271	
Total	10,843	9,902	10,039	10,209	10,576	

* Continuing Education was decentralized to all campuses beginning in 1970 which explains decline in enrollment at that time.

** Figure in parenthesis shows FTE computed according to new formula. See text.

Table 8. Enrollments, University of Maine at Presque Isle, Fall 1970 – Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	647	693	819	870	938	
Part-time	17	16	13	174	221	
Headcount	664	709	832	1,044	1,159	
FTE	655.5	701.0	825.5	957.0	1,048.5	
II. Continuing Education						
Full-time	0	36	42	31	14	
Part-time	496	425	441	279	216	
Headcount	496	461	483	310	230	
FTE	248	248.5	262.5	170.5	122.0	
III. Total						
Full-time	647	729	861	901	952	
Part-time	513	441	454	453	437	
Headcount	1,160	1,170	1,315	1,354	1,389	
FTE	903.5	949.5	1,088.0	1,127.5	1,170.5	(1,144.73)*
IV. Distribution by Residence						
In-state	1,133	1,144	1,266	1,281	1,310	
Non-resident	27	26	49	73	79	
Total	1,160	1,170	1,315	1,354	1,389	

* Figure in parenthesis shows FTE computed according to new formula. See text.

Table 7. Enrollments, University of Maine at Portland-Gorham, Fall 1970 - Fall 1974

	Fall 1970	Fall 1971	Fall 1972	Fall 1973	Fall 1974	
I. Campus Academic						
Full-time	3,346	3,581	3,699	3,696	3,608	
Part-time	130	116	108	392	760	
Headcount	3,476	3,697	3,807	4,088	4,368	
FTE	3,411.0	3,639.0	3,753.0	3,892.0	3,897.0	
II. Continuing Education						
Full-time	86	287	0	172	385	
Part-time	2,202	2,257	3,265	3,613	3,327	
Headcount	2,288	2,544	3,265	3,785	3,712	
FTE	1,187.0	1,415.5	1,632.5	1,978.5	2,049.0	
III. Total						
Full-time	3,432	3,868	3,699	3,868	3,993	
Part-time	2,332	2,373	3,373	4,005	4,087	
Headcount	5,764	6,241	7,072	7,873	8,080	
FTE	4,598.0	5,054.5	5,385.5	5,870.5	5,946.0	(5,383.7)*
IV. Distribution by Residence						
In-state	5,527	5,923	6,645	7,416	7,625	
Non-resident	237	318	427	457	455	
Total	5,764	6,241	7,072	7,873	8,080	

* Figure in parenthesis shows FTE computed according to new formula. See text.

Institutional Research Memorandum No. 14 will contain more detailed information and analysis of enrollment data.

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FIG. 3. FORMULATION OF ACTION SKILLS IN A CURRICULUM*

Action skills

At the time of graduation from medical school it is unrealistic to expect all students to have acquired a level of professional competence sufficient to justify **independent** management of any significant number of health problems. There are some areas, however, in which this competence should have been achieved, and these are listed below. In addition, any student should be able to formulate a general plan of management for the disease processes he is expected to recognize (and which are listed in an earlier section of this document). He should also be prepared to outline a diagnostic approach to prominent presenting symptoms and signs not immediately recognizable as specific diseases.

1. Independent management

- Routine screening procedure for adults, adolescents, children, infants
- Pre-marital and marital counselling, including contraceptive advice
- Normal pregnancy and delivery
- Emergency care, acute traumatic injury
- Emergency care, cardiac arrest
- Emergency care, acute poisoning (aspirin, lye, barbiturate, hydrocarbons, mescaline)
- Anterior nasal haemorrhage
- etc

2. General management plan

- See list of diseases to be recognized
- Physical rehabilitation for patients who have suffered myocardial infarction, stroke
- Schedule of immunization for infants, special risk groups
- To minimize health hazards according to age, sex, race, socio-economic status and place of residence
- etc.

3. Diagnostic plan - symptoms and signs

- Fever
- Pallor
- Weakness
- Jaundice
- Vomiting
- etc.

* Extracted from the curriculum of the Abraham Lincoln School of Medicine, University of Illinois College of Medicine.

alike can be freed from the artificial constraints of instructional time and sequence.

CURRICULUM PLANS

Traditionally a curriculum plan takes the form of a descriptive outline of courses, their arrangement and sequence, the time assigned to them, the content that will be covered in them, and the instructional methods that will be employed. Such a document guides faculty in preparing their instruction, tells students where to go and what experiences they can expect, and provides for external reviewers the kind of evidence that is generally sought when judgements are made about educational quality. But it tells none of these individuals or groups what the product of the curriculum is intended to be.

The "accountable curriculum" plan, on the other hand, would also be an outline but would focus upon a description of learning outcomes and the varied resources to which students might turn to achieve those goals. These resources might include formal course offerings, where they were appropriate and useful, but only as one of many modes that might be employed. This document would also serve faculty, but as a constant reminder that there is no single curriculum optimal for all students and as regular encouragement to create options and alternatives rather than pursue the unreachable goal of *the* curriculum. It would serve students as a definitive guide to what they are expected to become, not merely a timetable of 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 outcome rather than designed instructional content.

With such a curriculum plan in hand the task of evaluating student achievement is substantially simplified, since the first and most critical step in that process — specification of learning objectives — will have been completed as part of the planning. And this is where evaluation must begin, rather than being tacked on at the end.

But equally important is the opportunity such a plan provides for examining the outcome in terms of the social, economic, and political as well as the academic determinants. In any careful programme review each such determinant in turn should be used as a criterion against which the curriculum is judged. To the extent that it fails to meet these criteria, both the plan and the planning process must be re-examined to determine what went wrong. Were the determinants appropriately identified? Were the necessary interests and expertise represented in the planning group? Were priorities clearly established and did the planners adhere to these priorities in making curriculum decisions? Were those priority decisions reflected in the final curriculum plan as well as in the instructional tactics? It is through such systematic review that faults are identified and corrected.

But even if the criteria seem to have been met, the task of review does not end; instead the cycle should begin once more. Academic, social, economic, and political determinants are not static; the world changes, and with it the curriculum must also change to meet new needs as well as to exploit new opportunities. Curriculum theory demands that the process of planning be continuous, dynamic, and never-ending if it is to serve best the needs of individual students, educational institutions, and the society to which both are ultimately accountable. The time is at hand for that theory to be more fully reflected in contemporary curriculum planning practices.

ADDITIONAL READING

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SIMULATION IN INSTRUCTION AND EVALUATION IN MEDICINE

Christine H. McGuire[1] & Frederick H. Wezeman[2]

Sound clinical judgement requires not only a broad knowledge and understanding of health and disease and relevant professional habits and attitudes concerning the delivery of health care but also the application of complex cognitive and psychomotor skills. These skills include the collection, processing, and interpretation of data; using a variety of resources (including expert advice); ordering priorities and decision-making; manipulating a situation to alter it (including interacting with others to effect change); and monitoring the consequences of these manipulations and modifying decisions or actions to respond to the altered situation. Conventional methods of instructing and evaluating students, residents, and clinicians are often not optimally suited to the development and assessment of these important components of physician competence. Analogous problems in other fields have sometimes been resolved by the introduction of sophisticated simulators designed for both teaching and testing.

For example, with the advent of the space age, scientists throughout the world were made dramatically aware of the need to develop simulators capable of creating, in the gravitational field of the earth, the conditions and problems that astronauts would encounter in leaving that field, living from hours to weeks in a very confined area under conditions of zero gravity and finally re-entering the once familiar environment. The resulting simulators represent engineering feats that in some respects rival the space ships themselves. Yet no one questions that these costly technological marvels were indispensable: first, in assisting scientists to anticipate and work out alternative solutions to problems in a deliberate, step-by-step fashion, free of any pressures that

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time and danger ordinarily impose; and second, in providing space-flight crews with ample opportunity to practise these solutions in a risk-free environment, so that all could be assured of appropriate responses in the potentially dangerous situation of the real universe.

But space simulators for training astronauts are merely the most recent and technically the most sophisticated of a growing number of devices that have long enjoyed a deservedly favoured status as instructional adjuncts in the education of such diverse personnel as athletes, business executives, lawyers, and many other groups. However, despite widespread familiarity with the principles that underlie these intriguing approaches, and almost universal acknowledgement of their demonstrated effectiveness, simulation technology has only recently been introduced in medical education. Perhaps such limited exploitation to date is in part owing to the vision of astronomical costs conjured up by the word "simulator". However, recent developments suggest that, within reasonable financial limits, this exciting technology can be made available to medical educators to enhance the efficiency and effectiveness of learning and the validity and reliability of assessment.

THE ESSENCE OF SIMULATION

Reduced to its essence, simulation consists merely in placing an individual in a setting that imitates some aspect of reality, and designing a problem around that setting which requires that learner's active participation in initiating and carrying through a sequence of inquiries, decisions, and actions. The total situation must be arranged so that each of the learner's activities triggers appropriate feedback that he can utilize in subsequent decisions about pending action — decisions that may in turn modify the problem. Certainly one of the most important characteristics of simulation is that a problem can be initiated in standard form for everyone but evolve in quite different ways depending on the unique configuration of interventions that each respondent makes.

In continuing experimental work (Fig. 1) this essence has been captured in a variety of simulation modalities whose use is economically and technologically feasible in the development and assessment of critical components of physician competence.

TYPES OF SIMULATION IN CURRENT USE

The various types of simulation outlined below are based on a recognition that clinical and laboratory data come to the physician

FIG. 1. GROUPS EXPERIMENTING WITH SIMULATION

The following groups are currently engaged in experimental work with one or more types of simulations for instruction or evaluation.

University of Illinois
College of Medicine,
Chicago, Ill., USA

University of Miami
School of Medicine,
Miami, Fla., USA

Michigan State University
School of Human Medicine,
East Lansing, Mich., USA

The Royal College of Family Physicians of Canada,
Toronto, Ontario, Canada

The American Board of Orthopaedic Surgery,
Chicago, Ill., USA

University of Southern California
School of Medicine,
Los Angeles, Calif., USA

University of Iowa
School of Medicine,
Iowa City, Iowa, USA

McMaster University
Faculty of Medicine,
Hamilton, Ontario, Canada

The Australian Academy of General Practice,
Melbourne, Australia

At WHO headquarters, Geneva, Switzerland, a demonstration laboratory of instructional aids including simulations has been established under the direction of Dr. M. A. C. Dowling and certain intercountry studies initiated on the relative efficacy of some of the simulation models described in this paper

through various sensory modalities (e.g., visual, auditory, tactile) and that highly complex cognitive and psychomotor skills are involved in collecting and processing such data. These important facts are commonly ignored in much of the teaching and most of the testing characteristic of medical education, where all too frequently almost exclusive reliance is placed on verbal descriptions of highly complex and varied phenomena and processes.

Reproductions of visual and auditory stimuli

The utility of photographic reproductions of X-rays, lesions, gross and microscopic specimens, tracings of electrocardiograms, or electroencephalograms and the like — all presented in a form that imitates life as closely as possible — has long been recognized. More recently electronic techniques have been developed for the playback of high-fidelity recordings of heart, breath, and abdominal sounds using individual stethophones in a manner that simulates what the physician hears during his examination of a patient. Similarly, high-quality ciné-films or videotapes depicting patient interviews and examinations are generally recognized as invaluable for the presentation of data consisting of a combination of sound, colour, and movement.

For purposes of instruction, presentation of data in these forms makes it possible to control the difficulty of the material and to enable a student to focus on the essential elements, freed from the multiplicity of distractions that real life intrudes. For purposes of assessment, data presented in this manner can be employed in standardized test exercises that require the student to demonstrate that he has observed the salient findings and can describe them accurately, interpret their significance, and anticipate other findings to which they may be related. While such methods are being increasingly used in the instruction of the medical student, their utility in the evaluation of the student's competence is only now beginning to be recognized and is, as yet, inadequately exploited.

Three-dimensional models

More recently, prototypes of several three-dimensional simulators (e.g., breast, pelvis, prostate, eye, ear, larynx, infusion arm, intubation, spinal tap, etc.) have become available.[1] Varied pathology can be inserted in these devices to assist the student in learning and to require him to demonstrate that he has mastered the skill of using sophisticated instruments to elicit the findings and to interpret them.

For example, the Iowa Eye Model consists of a hollow styrofoam head with realistic, transparent cornea and pupils. The interior of the head is fitted with slots into which ordinary 35-mm slides of the fundus are inserted in front of a silvered surface designed to reflect the light from an ophthalmoscope back through the 35-mm transparency in a manner that enables the physician to visualize the retina much as he would in a real patient. Since standard 35-mm slides are used in a manner that makes them readily interchangeable, it is obvious that the findings in this model are capable of almost infinite variation. This important feature means that for purposes of instruction the findings can be carefully graduated in difficulty, while for purposes of assessment they can be selected to require the student or physician to demonstrate that he can make interpretations ranging from the gross distinctions expected of the beginner to the most subtle expected of the specialist.

[1] Penta, F. & Kofman, S. (1973) *J. med. Educ.*, 48, 442.

Automated robots

As an indication of the level of realism that can even now be attained in three-dimensional models, SIM I (developed at the University of Southern California for use by anaesthetists) and the new Cardiac Simulator (developed at the University of Miami) may be instructive. SIM I[1] is a computer-managed, extraordinarily life-like robot that can be programmed to present combinations of findings capable of modification in an almost infinite number of ways, to simulate a variety of problems, and to respond appropriately to different interventions of the anaesthetist. SIM I may even "die" if the student manages it inappropriately or responds inadequately to changes in its condition. The Cardiac Simulator,[2] although not computer managed, is equipped with a large number of programmes presenting varied auscultatory findings coordinated with appropriate visual pulses built into a life-like torso.

While these robots are at present available only in prototype form, they suggest some of the possibilities for using sophisticated simulation technology in the training and testing of medical students and residents.

Paper-and-pencil simulations

At the other extreme of the cost continuum are the written simulations of clinical problems,[3] widely known as branched problems in patient management (PMP), designed to imitate the decision-making process involved in the "work-up" and management of a patient. In these problems a clinical situation is introduced with a brief statement of a complaint such as a physician might elicit from the patient himself, from a friend, from a relative who accompanied him, or from a colleague who referred him. It may consist of a few written lines or a brief length of a film in which the patient indicates his reason for "seeing the doctor".

The statement of the problem is followed by a list of interventions or of general strategies; from these an initial approach may be selected, e.g., further history, physical examination, laboratory evaluation, or immediate therapy. This decision is recorded by erasing the opaque overlay or developing the latent image on a specially treated answer-sheet to reveal the requested information or further instructions.

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1 Abrahamson, S. et al. (1969) *J. med. Educ.*, **44**, 515.
2 Gordon, M. (1971) *Computerized automated mannequin, a self-testing method* (unpublished, available from the University of Florida School of Medicine, Miami, Fla., USA).
3 McGuire, C. & Solomon, L., ed. (1971) *Clinical simulations: selected problems in patient management*, New York, Appleton-Century-Crofts.

In each new section possible interventions that may yield further information about the patient or modify the patient's condition are listed. The respondent selects as many or as few as seem appropriate in light of the specific circumstances obtaining at that stage of the problem. As each decision is recorded the results of that intervention are revealed in realistic verbal or visual form. As the problem unfolds, the student must make further choices based on the *specific* responses of the patient evoked by *his own* earlier decisions. The complications that the must manage will depend, as they do in the consulting room or clinic, on the unique combination of specific procedures that were selected at earlier stages.

This type of paper-and-pencil simulation has been found suitable for both diagnostic and management problems ranging from emergency to long-term chronic disease conditions that may involve psychosocial as well as organic factors. Recent technical developments make it possible for the local faculty to devise such simulations and to reproduce small quantities of them in latent image by means available in any secretarial office and at a cost comparable with other inexpensive duplicating procedures.[1]

Computer-aided simulations

A rationale analogous to that used in the construction of written simulations has been employed in the development of a variety of types of computer-assisted simulations of the clinical encounter. Although the specific details vary, in essence all are designed to imitate some aspect of the decision-making process in the investigation and management of patients.

In some such simulations the student makes selections from a list of options presented by the computer; in others he must formulate his own inquiries and interventions with neither the assistance nor the constraints of a list. For example, in the CASE format, developed at the University of Illinois,[2] the computer takes the role of a patient and the session is introduced by a computer statement describing the setting (physician's consulting room, hospital, emergency room, etc.) and the patient's age, sex, and general appearance. The computer may go on to state, as a patient would, the reason why the patient has come to see the physician. Or alternatively the session might simply begin as follows:

Student: What brings you to see me?

[1] McGuire, C. et al. (1974) *Written simulations: their construction and analysis* (unpublished, available from Center for Educational Development, University of Illinois College of Medicine, Chicago, Ill., USA).
[2] Harless, W. et al. (1971) *J. med. Educ.*, 46, 443.

Computer: Well, I am just tired all the time. I don't ever feel rested and all my energy is gone.

Student: How long has this been going on?

Computer: About six months ago I started feeling tired all the time. I finally felt I had to do something about it.

Student: What did you do?

In this fashion, the student may question the computer-patient about the history and presenting complaints and the computer responds as the patient would. At any point in this interaction a physical examination or laboratory evaluation may be initiated. In response to each *specific* inquiry the computer provides a technical description of the physical findings or the laboratory report requested. At the conclusion of this data collection the student records both his diagnosis and his plan of management. At this point the computer assumes the role of a consultant and immediately responds with a display comparing the data actually gathered with the optimal data base and the proposed diagnosis and management plan with the consultant's conclusions and recommendations.

In an alternative type of computer programme for simulating the patient–physician encounter, developed at the National Institutes of Health,[1] the student must also manage simulated time and cost in a realistic manner. Here, the task is to arrive at the correct diagnosis with a minimum appropriate expenditure of time and money. At any point in the session the diagnosis may be entered; the computer will then respond with an evaluation of its accuracy and a summary of the time and money cost incurred compared with the cost of the optimum approach.

Irrespective of their specific focus and methodology, all computer-assisted simulations are designed to provide the student with instantaneous feedback on the results of his decisions and an immediately retrievable record of his entire decision-making sequence for objective analysis and evaluation.

Live simulations

Realistic clinical problems can also be posed through live simulations in which an actor, housewife, another student, or almost anyone can be "programmed" to simulate a patient in an interview setting. In principle, live simulations differ from written and computer problems in only two respects: first, the student/physician must necessarily generate

[1] Friedman, R.A. (1973) *J. med. Educ.*, 48, 92.

his own inquiries and interventions; and second, he must formulate them in a manner that is meaningful to the "patient".

In a simulated diagnostic interview,[1] for example, the student may be directed to interview the programmed patient and elicit data from him; in a management or therapeutic interview it may be the student's task to persuade the simulated patient to accept a recommended plan of management. In either case, the simulated patient is programmed to display the reluctance, anxiety, and need for understanding and emotional support that such patients display in real life. And it is the student's task to communicate clearly and convincingly with the patient in order to gain his full cooperation.

Skills in data collection, long-term care, or crisis management have been explored by means of a variety of such techniques. In a telephone simulation, for example, the student is seated in a setting similar to a consulting room when the telephone rings and a frantic voice on the other end of the line reports some emergency—an accident, a child suspected of ingesting poison, a suicide threat, or the like. The physician is required to respond as he would to a real-life emergency and the adequacy of his response can be reliable analysed, either for purposes of certification or for further learning.

Live simulations have also been used to teach and to assess various skills in patient examination. Of special note in this regard is the experience of Dr Howard Barrows and his associates in programming simulated patients to display the physical findings of various neurological disorders.[2]

Similarly, the physician's interpersonal skills and attitudes can be enhanced as well as assayed by carefully designed simulated interviews and conferences in which an individual — again, not necessarily a professional actor — is programmed to take the part of a patient, a colleague, or other member of the health team.[3] Such interviews can be developed to focus primarily on the student's sensitivity and skill in handling various types of patients; on important referral, consultation, and conference skills, including those required in the delicate situations in which colleagues differ sharply about the management of a particular patient; or on skill in communicating with other members of the health team (e.g., instructing a nurse, requesting assistance from dietitian or social worker, or making a presentation in a staff conference). Such simulations are useful in assisting the student to develop, and his mentors to evaluate, the range of communication and interpersonal skills essential to effective functioning as a physician.

[1] Levine, H. & McGuire, C. (1970) *J. educ. Meas.*, 7, 63.
[2] Barrows, H. (1972) *Simulated patients*, Springfield, Ill., Thomas.
[3] Levine, H. & McGuire, C. (1970) *J. med. Educ.*, 45, 700.

Future directions

In short, reproductions of clinical and laboratory data, three-dimensional models, automated robots, written simulations, computer simulations, and live simulations can all be used to present clinical problems in a realistic form that (*a*) enables the student to learn, and requires him to demonstrate that he has learned, how to respond as he would in the consulting-room or clinic setting; (*b*) permits him to receive life-like feedback from the simulator; and (*c*) forces him to cope with the results of a sequence of inquiries and interventions, much as he will have to do in his actual practice.

Though simulation technology is still relatively new to medicine these methods are already being employed in teaching and testing medical students, residents, and clinicians. It may in the near future be possible to combine various simulation modalities in a manner that further enhances their utility. For example, a computer simulation could be merged with a live simulation so that a constantly updated computerized data bank is made available to supply information about the pathology (e.g., physical and laboratory findings) that a live simulator is incapable of providing. Such a simulation could be extended to cover the full time period beginning with the presentation of the patient and concluding only after appropriate treatment has resolved the problem and the evident changes in the "patient's" condition have met suitable criteria for discharge. In such a problem changes over time in the patient's condition induced by, and resulting from, intervention by the physician would be reflected not only in modified findings supplied by the computerized data bank but also in changes in the specific roles and reactions of the simulated patient and of the physician. Thus, a complete clinical encounter could be simulated in a condensed time period. But merging live and computer simulations is only one of the many possible ways of combining all types of simulation modalities to increase their versatility and effectiveness in medical settings.

THE USE OF SIMULATIONS

In instruction

As indicated above, the various simulation methods now available in medicine can be employed as instructional resources not only in the development of diagnostic and problem-solving skills, but also in the development of psychomotor and interpersonal skills. Clearly, these simulations can provide more valid educational experience than many of our conventional modes of instruction. However, this increased validity depends upon the fidelity of the simulation, whether it is presented in a live, computer, paper-and-pencil, or other format. While fidelity is a relevant consideration in all simulation methods, the problem is particularly acute in the development of three-dimensional models, in which it has been especially difficult to simulate tissue characteristics accurately. With the advent of improved materials and better production techniques it has now become possible to develop sufficiently accurate representations of human anatomy for teaching some of the skills of physical diagnosis. Analogous advances in electronics have led to the development of more compact electronic simulation devices (such as the Humetric Sound Device) that electronically synthesize heart sounds and other phenomena in the body. These, too, have proved of great value in assisting medical students to develop skill in interpreting certain types of physical findings.

Such innovations afford more *efficient* means of (*a*) focusing upon a specific learning objective; (*b*) rendering the experience reproducible; and (*c*) allowing a standardized approach for all students. In the use of simulation devices it is important to keep clearly in mind the nature of the desired behavioural outcomes, since the ultimate goal is the subsequent independent performance of the skill in a non-simulated setting. The degree to which a learned skill is transferable from a simulated setting to a live patient situation depends not only on the fidelity of the device itself but also on its incorporation into a systematic total educational approach. Mere *exposure* to a device affords the student a chance to experiment with or interact with the device only at a superficial level. On the other hand, the development of associated programmed instructional guides that direct the student–device interaction magnify the relevant aspects of the experience. Thus, statements of the goals and objectives of the experience with the device, performance skill expectations, methodological instructions, and evaluation items expedite the acquisition of the skill, direct the interaction with the device, and guarantee a profitable experience.

In assessment

The results of current research suggest that simulation techniques of the types described here are especially useful in evaluating (*a*) skill in gathering and interpreting clinical and laboratory data; (*b*) judgement in patient management; and (*c*) the professional skills and attitudes required for effective interaction with patients and colleagues (Table 1).

Interpretative skills. Clearly, greater reliability can be placed on any judgement about a student's interpretative skills if he asked to interpret data presented in the form in which he usually encounters them rather

TABLE 1. SIMULATION AS AN EVALUATION TECHNIQUE

Competence tested	Type of simulation	Illustrative technique
Interpretative skills	Simulated clinical and laboratory data	Photographic reproductions Sound simulators Ciné-films and videotape Three-dimensional models Automated robot — SIM I
Problem-solving skills and clinical judgement	Simulated problems in patient management	Written simulations (PMP) Computer-assisted simulations (CASE) Automated robot simulations (SIM I) Live simulations (telephone, surgery, etc.)
Interpersonal skills and attitudes	Simulated interviews and conferences	Programmed patients Programmed colleagues Programmed teams

than verbal descriptions of such data. For this reason, the use of photographic reproductions, sound simulators, motion pictures and videotape, three-dimensional models, and more sophisticated robots are of particular use in assessing this important aspect of clinical competence.

Problem-solving skills and clinical judgement. Patients ordinarily present with a chief complaint, which the physician must explore and manage. Thus there is a certain "face validity" to any technique that confronts the student with a problem in this form, provides him with an opportunity for considerable latitude in choosing his own approach, and enables him to receive prompt feedback on the results of any inquiry or intervention he makes. Clearly it will be more useful in assessing the student's clinical judgment than the more traditional exercises that ask him to list the signs and symptoms of various diseases, and the most probable diagnosis from a carefully predigested summary of the salient data.

Professional skills and attitudes. Too often in the past, medical educators have either failed to evaluate psychomotor and interpersonal skills or have attempted to make inferences about these essential components of competence from the student's verbal description of his interaction with a patient or from the written record of a patient investigation. Clearly, both sources of data are inadequate for a valid assessment of skills and attitudes. These can be judged only by observing the student with a patient. However, since the student may behave differently with different patients and since patients must not be put at risk from incompetent interventions, observation of the student with simulators, both mechanical and live, would seem to be the most promising alternative.

CRITERIA FOR USING SIMULATION

In instruction

Certain criteria for the use of simulation devices have been implied in the preceding discussion; it would be possible to identify others that are especially pertinent to the instructional uses of simulators. To catalogue them, however, would be unrewarding since many relate merely to common sense and good judgement. First among these is the requirement that the development and use of a simulator parallel curricular needs. This assurance, together with the advice of members of the teaching faculty, guarantees that experience with the device will be a supportive extension of the stated curriculum, as well as one that gathers support for further application of such aids to the teaching programme by the faculty members themselves.

No matter how clearly the experience coincides with stated curricular needs, or how apparently acceptable it may be to teaching faculty and students, other sources of difficulty may jeopardize the validity of an experience with simulators. Such problems may arise from the physical nature of the devices themselves. In the area of anatomical replications, commercial development in the past has poorly satisfied the need for instructional accuracy in terms of texture, size, apparent "tissue" density, or mobility. The resulting lack of structural reality sets an incomplete stage for the interaction of the student with the device.

In addition, careful attention must be given to the level of education in question, the placement of skill learning in the educational continuum, and the knowledge that must be attained before experience with a specific simulation device is of maximum benefit. Obviously, the simple skill of performing a pelvic examination can be acquired without understanding the normal or abnormal pathology and physiology of the female reproductive system. Appreciating the importance and value of either the simulated or real experience demands a knowledge of basic sciences, pathology, and some fundamentals of obstetrics and gynaecology. Thus, it is of greater value to expose a student to a simulated learning device at an appropriately defined time in his training.

In assessment

In selecting simulation techniques for purposes of evaluating individual competence and/or curricular effectiveness, the same considerations apply as in the choice of any other testing and evaluation technique. As with the instructional uses of simulation, it is first necessary to decide exactly what aspect of competence is to be measured at each level of education and experience. Once this decision has been made, then the most appropriate technique is that which requires the student to perform a task resembling as closely as possible the real-life performance for which he is being examined (test validity). Secondly, it is necessary to design the task in such a manner that different observers who are evaluating the student will agree about the character of his performance in the test situation (objectivity or inter-rater reliability). Third, it is essential to create a sufficient number and variety of tasks to ensure that one can safely generalize from the student's performance on the test exercises to his overall level of competence (sampling reliability). Finally, both economic feasibility and logistic considerations must be taken into account in selecting any assessment technique. These four criteria should be borne in mind in reviewing the advantages and limitations of the simulation techniques elaborated upon below.

ADVANTAGES AND LIMITATIONS OF SIMULATION

Simulation *imitates*, it does not *duplicate*, life; this is both its greatest advantage and, in the view of some, its greatest limitation. Clearly there are some aspects of reality that cannot at the present time be economically simulated, if they can be simulated at all. Thus, it is necessary to be very cautious about predicting on the basis of responses to a simulated situation how an individual *will* behave in reality; at best it is possible to predict how well that individual is *capable* of behaving. (The same caution must, of course, be observed in predicting how an individual will behave in a *new* life situation on the basis of how he behaved in a *prior*, necessarily *different*, life situation).

Further, it is important to recognize that simulation is not an appropriate method for teaching or for measuring all aspects of performance. For example, factual information is more economically conveyed and more directly measured by conventional techniques of instruction and testing. On the other hand, appropriate professional habits are most firmly entrenched by repeated reinforcement over a long time-span in diverse settings; they are most reliable assayed by careful and repeated observation under similar conditions. Between these two extremes simulation provides the following important advantages.

Perceived relevance. As compared with more conventional teaching and testing techniques, simulation offers the possibility of designing instructional and assessment exercises so that they correspond more closely to the situations a physician actually faces. Such materials appear to the student as far more relevant than typical readings, lectures, multiple-choice tests, or traditional oral quizzes. Such perceived relevance is at the very least of psychological and motivational benefit.

Predetermination and preselection of the task. It is important to note that this relevance can be achieved without dependence on the flow of patients available at the particular place and the specific moment in time that instruction is to take place or assessment is to be made. Thus simulation makes it possible to predetermine precisely the exact task that students are to learn or to demonstrate that they can perform. Further, by suppressing the undesired distractions always present in reality, it is possible in a simulation to focus on the elements of primary concern and to eliminate irrelevant, confusing complexities that complicate learning and contaminate assessment.

The fact that simulated tasks can be preselected also means that they can be carefully graduated in difficulty as a student or resident progresses through training — a factor of prime significance in increasing the efficiency and effectiveness of both instruction and evaluation. Finally, by developing standard parallel simulations it is possible to confront a student again and again with challenging variations of what is essentially the same task until he has mastered it and can demonstrate that mastery to any examining body.

Standardization of the task. Just as a single student can be repeatedly confronted with the same task, simulation enables an examining body to standardize the task for all examinees, and to do so without subjecting one or a few patients to repeated harassment by a large number of students. In short, all examinees can be given exactly the same problem to cope with and this can be accomplished without risk to any patient.

Improved sampling of performance. By standardizing the tasks and focusing on the most significant aspects in each it is possible in a given time period to expose the student to, and to sample his performance on, a much broader and more representative group of problems. This, of course, requires careful selection and definition of the tasks, but that is precisely the luxury simulation affords that reality can rarely provide in a reasonable time frame.

Improved rating of performance. When the exact tasks that are to compose an instructional unit or an evaluation exercise are precisely defined and preselected it is possible to record the student's performance in detail for subsequent feedback in a manner that maximizes his learning. Further, for purposes of evaluation it is possible to develop specific criteria for judging performance, and to train examiners in applying these criteria equitably and consistently. Thus the degree of inter-rater reliability that can be achieved in scoring examinee performance with simulated problems and simulated interviews is far superior to that achievable with real patients.

Increased responsibility and realistic feedback in a practical time frame. One of the most important advantages of simulation over reality consists in the fact that all students and residents can be allowed full responsibility for the work-up and management of the simulated patient without any risk whatsoever to actual patients. Even if the student's interventions with the simulated patient are grossly inappropriate he can be allowed to continue without supervision, to receive realistic feedback, and to learn the consequences of his action from first-hand experience, without harm to anyone. The simulated patient can develop complications induced by faulty management, get very much worse, die, commit suicide, and yet be repeatedly revived, tirelessly to serve in the edification and examination of the same or other students.

Compression of real time. Furthermore, it is often essential to provide a student experience with, and to test his mastery in the handling of, chronic disease without his spending months or years observing the gradual deterioration of a real patient. In carefully developed simulations a lifetime of chronic disease can be compressed into a half-hour problem, at each stage of which the student can be provided with feedback about his interventions in a form that is more instructive than life itself usually yields.

Increased learning. The nature of the feedback provided in simulations as compared with that available in either conventional educational settings or in reality should be stressed. While the former rarely provides any genuinely relevant feedback, the latter often furnishes it only indirectly, equivocally, and after a long delay. In contrast, the prompt, specific, and unambigious feedback characteristic of well-designed simulations makes them a powerful tool for the enhancement of learning.

RELATIONSHIP OF SIMULATION TO OTHER INSTRUCTIONAL AND EVALUATION STRATEGIES

Enumeration of the foregoing advantages should *not* be construed as a recommendation that conventional, instructional and evaluation strategies be entirely replaced by simulation techniques; nor should it be interpreted as suggesting that simulation is a pale, but adequate, substitute for the real thing when the latter is unavailable. Rather, simulations should be viewed as important adjuncts to other educational methods. Their power lies in the fact that they select out manageable segments of the total physician/patient relationship for study. However, this very fragmentation, in turn, requires that provision be made for the student to experience through conventional patient contact the total interaction at appropriate points in his professional development.

CONCLUSION

In summary, the evidence from studies of the use of simulation at several levels of medical education and with a variety of types of groups suggests that when these techniques are properly exploited, simulation technology gives considerable promise of increasing the effectiveness of instruction and the validity and reliability of assessments of more relevant and complex objectives of medical education. Simulation appears to offer special advantages as an effective technique not only in teaching and assaying specific, circumscribed skills but also in developing and evaluating that most significant objective of all — clinical judgement.

ADDITIONAL READING

Abrahamson, S. et al. (1969) *J. med. Educ.*, **44**, 515
A description of a computer-managed automated robot designed for use in the instruction of residents in anaesthetics.

Barrows, H. (1972) *Simulated patients*, Springfield, Ill., Thomas
A description of the techniques of training and experience in using simulated patients for instructing medical students in neurological examination.

Friedman, R. (1973) *J. med. Educ.*, **48**, 92
A description of the method of interacting with the computer on a series of problems into which real time and money costs are programmed and where management of these aspects is an essential part of the diagnostic process.

Gordon, M. (1971) *Computerized automated mannequin, a self-testing-training method, progress report. American Heart Association 44th Annual Scientific Session, Anaheim, California, Nov. 11-14, 1971* (mimeographed document available from Section of Cardiology, Dept. of Medicine, University of Miami School of Medicine, Miami, Fla., USA).
Description of a mannequin designed to receive a variety of programmes in which auscultatory findings are simulated and coordinated with the visual presentation of pulses in the mannequin.

Harless, W. et al. (1971) *J. med. Educ.*, **46**, 443
Description of the interaction with the computer in simulated clinical encounters in which the student addresses the computer in unconstrained natural language without resort to any cueing list.

Levine, H. & McGuire, C. (1970) *J. educ. Meas.*, **7**, 63
Description of the experience of a major surgical specialty board in using simulations to assess candidates' diagnostic and management skills.

Levine, H. & McGuire, C. (1970) *J. med. Educ.*, **45**, 700
Description of the experience of a major surgical specialty board in using simulated patients to assess skill in communicating with the patient and gaining the patient's cooperation in a plan of management.

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Twenty selected problems in patient management, presented in the form of paper-and-pencil simulations, in paediatrics, internal medicine, surgery, neurology, orthopaedics, obstetrics, and gynaecology.

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A Handbook describing in detail the techniques of constructing, reproducing, scoring, and analyzing paper-and-pencil simulations.

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A set of telephone simulations with instructions for their use in the assessment of personnel readiness to man a suicide prevention centre.

EXAMINATIONS AND DECISION-MAKING

James A. Bobula[1]

One of the most challenging tasks facing medical educators is that of developing examinations that measure accurately and assess appropriately the adequacy of student knowledge, skills, and professional attitudes. This evaluative task is of such importance because it is chiefly through examination data that teachers monitor student progress through medical school, identify those who are to qualify as physicians, and thus ultimately control both the quantity and quality of the physicians available to society. This paper deals in an introductory, non-technical fashion with the systematic planning, scoring, and reporting of examinations to serve those critically important functions.

No single examination can provide adequate data for all the decisions a faculty must make about medical students. Each examination, however, is most likely to serve a particular evaluative need if it is designed from an explicit statement of the decision a faculty must make and is developed to provide the specific data required for that decision. For example:

A Proficiency Examination will be administered to incoming first-year students to determine whether any student has sufficient mastery of: (*a*) one or more disciplines within the basic science curriculum to warrant either placement into advanced courses or exemption from regular courses in such disciplines; or (*b*) the basic medical sciences as a whole to warrant placement directly into a clinical curriculum.

Given such a statement of purpose, the particular examination characteristics that are consistent with the decision to be made must be specified and the examination planned on the basis of those specifications. The example summarized in Table 1 is further developed below.

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TABLE 1. EXAMINATION PLAN

Examination characteristics	Proficiency examination example
1. Scope of material covered	The content will systematically represent the entire basic science curriculum, according to a blueprint developed by a special faculty committee composed of one representative from each basic science discipline.
2. Format	Multiple-choice questions with only one correct answer will be employed exclusively in the examination.
3. Nature of data (i.e., type of scores)	A student will receive a score indicating the percentage of his answers that were correct in each discipline and in the examination as a whole.
4. Basis for decision (i.e., standard of adequate performance)	A minimum passing percentage score will be established by the faculty committee prior to the examination for each discipline and for the total examination. A student will be considered at least minimally competent in a particular discipline or in the basic sciences as a whole if he obtains a percentage score equal to or greater than its corresponding minimum passing percentage score.
5. Critical review	The faculty's Appraisal Committee will review the examination blueprint prior to administration of the examination to approve its specifications. After the examination is administered, the Committee will assess the reliability (internal consistency) of the examination and will perform an item analysis to determine whether any of the multiple-choice questions were ambiguous to the students and must be deleted from scoring.
6. Reports	A report of each student's percentage scores and the minimum passing percentage score for each discipline and for the total examination will be made available to the student himself, to his faculty adviser, and to the faculty committee responsible for deciding on advance placements.

Step 1: state the purpose

A statement of purpose should indicate the reason for which an examination is being constructed and administered, specifying (*a*) the group of students to be examined, (*b*) the areas on which they are to be examined, and (*c*) the decision that the staff must take on the basis of the examination results.

Specification of the group of students to be examined enables definition in *broad* terms of the skills required (e.g., students at the end of the first year and of the fourth year might both be expected to know something about cardiac arrhythmias, but at quite different levels of competence). Specification of the content about which the students are to be examined tells what *particular* areas are to be dealt with in this examination. Specification of the decision to be made about the students indicates how the examination data are going to be used in evaluating student performance, i.e., to monitor a student's progress (diagnostic examinations) or to judge competence at some significant transitional point (certifying examinations).

Diagnostic examinations assess mastery of a *specific unit* of instruction so that a decision may be made whether or not further learning experiences are necessary. Their purpose is to advise students in planning subsequent learning activities. Diagnostic examinations include pre-tests to determine what a student knows about certain topics before they are formally treated in the curriculum, mid-unit tests to assess progress during instruction, and post-tests to determine whether the expected levels of proficiency have been achieved by the end of an instructional unit.

Certifying examinations, on the other hand, assess mastery of an *entire area* of study so that a decision may be made on promotion, graduation, or licensure. Certifying procedures include placement examinations, which permit a student to bypass formal instruction in areas that he has already mastered; comprehensive examinations, which document a student's achievement of professional competence at the end of a formal course of study; and licensing examinations, which testify to the right of professional practice.

Step 2: determine what is to be examined

In order to achieve a specified purpose, it is necessary to develop a detailed blueprint outlining both the content of the examination and the performance processes the students are expected to demonstrate with respect to that content. "Content" refers to the body of knowledge, set of skills, or focus of attitudes on which the students are to be examined. "Performance processes" refer to what the students are expected to be able to do with the content being examined. In the area of cognitive performance processes, for example, students might be expected: (1) to simply *recall* information ("What is X?"); (2) to *interpret data* using this information ("Knowing what X is, what do these data mean?"); or (3) to *solve a problem* by fitting this information together with other information in reaching a conclusion about a complex phenomenon ("Knowing the nature of X and its relationships to A, B, and C, what is the nature of Z?").

An examination blueprint is best presented as a table of specifications that lists relevant content areas on one axis, relevant performance processes on the other, and the proportion of the examination to be devoted to each content/process combination within the cells (Table 2). The proportions generally reflect the relative importance of these elements: more important areas are given greater weight in the examination; less important areas receive a smaller portion or are eliminated entirely.

TABLE 2. EXAMINATION BLUEPRINT: COGNITIVE DOMAIN

		Performance processes		
		Recall	Interpretation	Problem-solving
Content areas	% of examination	30	40	30
Area 1	20	12	8	0
Area 2	35	5	10	20
Area 3	10	3	4	3
Area 4	20	8	6	6
Area 5	15	2	12	1

The development of a blueprint and preparation of test materials according to that design increase the probability that the examination's content will be consistent with its purpose and that the performance data will provide a sound base on which to make the decisions for which the examination is intended.

Step 3: determine the format

"Format" refers to the types of examination materials and methods selected to measure the specified contents and processes. Formats are broadly categorized as "free-response" or "fixed-response" types. Free-response methods, which allow a student to respond to a question or a situation with his own words or actions, include oral examinations, extended-response written questions (essays), and short-response written questions (simple direct questions, sentence completions). The unstructured description of student behaviour by faculty observers is also a free-response type, although in this case the response is made by the observer and not by the student himself. Fixed-response materials, which require adherence to a predetermined form, include true/false, multiple-choice, and matching questions, patient management problems, and checklists or rating scales completed by examiners observing student behaviour in either an oral examination or a natural performance setting.

Free-response examinations have the advantage of requiring a student to respond independently, drawing solely on his own resources. They have the disadvantage of being virtually impossible to correct and score mechanically and are often subject to such extraneous influences as an examinee's general verbal fluency, an examiner's lack of clear criteria for essential elements of a correct response, or differences in judgements made by various examiners. Fixed-response examinations, on the other hand, can be scored mechanically or by any examiner with a listing of the correct responses. Their major disadvantages are that students might respond correctly by guessing or might be cued to correct responses by the options offered. Since skilful development of fixed-response formats allows testing of many complex as well as simple objectives of medical education, the additional advantage of objectivity and ease of scoring recommend them highly for most examination purposes.

Selection of a particular format should be determined primarily by the degree to which it requires a student to perform the desired process in the specified content area. For example, when the *purpose* of an examination is to assess the student's competence in obtaining a patient's medical history it is *more* appropriate to have a trained examiner with a fixed-response checklist observe him taking a history than to ask him, "What questions should be used routinely in obtaining a patient's medical history?"

Finally, an examination need not be limited to a single format. The blueprint can prescribe the use of different formats within an examination wherever they are most appropriate.

Step 4: develop a scoring system

The purpose of a scoring system is to summarize performance in some symbolic form that can serve as a basis for rational decision about the adequacy of that performance. Selection of the specific method should begin with a clear statement of exactly what the score is intended to mean. Such a statement might read: "A student's score in each discipline included in the Proficiency Examination will indicate the percentage of the total content of that discipline that he has mastered."

In ord… for a score to have this meaning, the examination blueprint must ensure that the total content of each discipline is systematically represented. Unless it is the score cannot indicate a mastery of the total discipline but only the components that were included.

Assuming that the blueprint supports the scoring purpose, it will then be necessary to assign some numerical value to each response a student makes. Since the form of the response depends upon examination format, assignment of values must be consistent with that format. If, for example, multiple-choice items having a single correct response are employed, then a correct response might be given a value of 1 and any other a value of 0. Multiple-choice items having several correct options would require a different procedure. For example, with three correct responses each might be assigned a value of 1 (so that a student could receive values of 0, 1, 2 or 3 for the item) or a value of 1/3 (so that a student could receive values of 0, 1/3, 2/3 or 1 for the item).

Finally, the values assigned to each response must be capable of summarization in a single score by means of some mathematical formula that clearly expresses the intended meaning. In the Proficiency Examination example, a formula meaning "percentage of the total content of a discipline that a student has mastered" would be: the sum of the values assigned to each of the student's correct responses in a discipline divided by the sum of the values assigned to *all* correct responses in that discipline. Following this formula, if a student correctly answered 96 of 120 multiple-choice items with single correct responses in a given discipline, his score would be 96/120, or 80%. The meaning of this score is: "The student has mastered 80% of the content of this discipline."

So long as the desired meaning of a score can be stated and that meaning supported by the examination content, the method of assigning values to correct responses, and the summary formula, it is possible to generate scores assessing nearly any skill expected of the students.

Step 5: set standards appropriate for the decisions to be made

Since examinations are the principal method of determing the adequacy of student performance, each aspect of performance about which a decision is to be made must be assigned an appropriate score in accordance with step 4 of the examination plan. These scores provide the *data* from which judgements will be made. In step 5, a standard of acceptable performance is established for each component of the examination in order to provide faculty with a basis for a *decision* about whether individual performance is adequate or inadequate.

There are two principal approaches to the establishment of performance standards: normative and criterion. In the former, an individual student's performance is assessed only in comparison with the performance of all others taking the examination. In the latter, the adequacy of an individual student's performance is determined in relation to an absolute standard established before the examination is administered.

Whatever the method, application of a standard to a student's score results in the assignment of an assessment symbol. For example, based on the total scores in a comprehensive examination the faculty might wish to award special recognition to the three top students. Here a normative standard is employed, ranking performance according to total score and giving special acknowledgement to the first three ranks. In another case, the faculty might merely wish to determine who "passes" and who "fails". Here a criterion standard is employed, and each student's score is compared with the minimum acceptable performance level, resulting in an assessment symbol of *P* (pass) or *F* (fail).

Table 3 illustrates several sets of commonly used assessment symbols that might be assigned to the performance of twenty medical students in a single examination. Each set of symbols is further explained below.

Normative standards

1. *Rank:* the place an individual score occupies in an ordered listing of all scores sequenced according to magnitude. The symbol 1 indicates first, 2 indicates second, etc. If more than one person has a particular score, all persons with that score are assigned the same rank symbol, e.g., 5.5 is assigned to students *e* and *f*, who together occupy the fifth and sixth rank positions.

2. *Percentile rank*: the percentage of students with scores below a particular score. The symbol 80 for student *d* indicates that 80% of the students had scores *below* his.

3. *Z-scores:* the number of standard deviation units by which a particular score departs from the group average (mean) score. The standard deviation is a statistic that describes the variability in a set of scores. The z-score of 1.08 indicates that student *c* is 1.08 standard deviations above the group average (the standard deviation in this

TABLE 3. ILLUSTRATIVE ASSESSMENT SYMBOLS

Student	Score	Normative				Criterion	
		Rank	Percentile	Z-score	Letter	Pass/Fail	Letter
a	89	1	95	1.50	A	P	O
b	87	2	90	1.29	A	P	O
c	85	3	85	1.08	B	P	O
d	81	4	80	.67	B	P	S
e	80	5.5	70	.57	B	P	S
f	80	5.5	70	.57	B	P	S
g	79	7.5	60	.46	C	P	S
h	79	7.5	60	.46	C	P	S
i	77	9	55	.26	C	P	S
j	75	10.5	45	.05	C	P	S
k	75	10.5	45	.05	C	P	S
l	74	12	40	—.05	C	P	S
m	72	13	35	—.26	C	P	S
n	71	14.5	25	—.36	C	P	S
o	71	14.5	25	—.36	C	P	S
p	69	16.5	15	—.57	D	P	S
q	69	16.5	15	—.57	D	P	S
r	68	18	10	—.67	D	F	U
s	65	19	5	—.98	F	F	U
t	44	20	0	—3.15	F	F	U

illustration is 9.68, the mean is 74.5, and the student's score is 85). Z-scores are useful in comparing a student's relative position in the group on a series of different examinations.

4. *Letter-grades:* in this case the symbols A, B, C, D, and F indicate excellent, very good, average, poor, and unsatisfactory respectively, and are based upon percentile ranks so that the categories include approximately the following distribution: 10% A, 20% B, 40% C, 20% D, and 10% F.

Criterion standards

1. *Pass/fail:* the assessment symbol P is assigned to all scores at or above the predetermined passing score, and F to those below. For this examination, the faculty determined that a score of 69 would be required for passing.

2. *Letter-grades*: in this case, the faculty agreed in advance that

scores of 84 and above would be considered outstanding (O), between 69 and 83 satisfactory (S), and 68 or below unsatisfactory (U).

The standard selected for judging student performance must be consistent with the purposes of the examination. In a Proficiency Examination designed "to determine whether any student has sufficient mastery of one or more disciplines within the basic science curriculum or of the basic medical sciences as a whole," it would be inappropriate to apply a normative standard. It is entirely possible that *none* of the students is proficient enough in all disciplines to merit certification. The only sensible standard would be a predetermined criterion requirement — a minimum passing score established in advance as the minimum acceptable evidence of mastery of the examination's content. If the standard employed in evaluating student scores is not consistent with the purpose of the examination, it is impossible for a faculty to make sound decisions.

Step 6: establish procedures for examination review

Even the best efforts of skilled examiners do not always yield a perfect examination, one that accurately characterizes the abilities of the students. Consequently it is necessary to establish procedures to evaluate the examination itself before reporting results. Important areas for such evaluation include the following.

Adequacy of content. The examination blueprint should be reviewed to determine whether the examination covers the intended content and process categories in a manner consistent with the purposes of the examination. The examination materials should also be reviewed to determine whether or not they meet the specifications set forth in the blueprint. These analyses are best undertaken before the examination is administered and by persons sufficiently familiar with the curriculum to make judgements on content adequacy (but not the same persons who developed the blueprint and examination materials). Whenever deficiences are discovered, the content must be improved before the examination is given.

Clarity of items. It is also important to review individual items for conceptual and verbal clarity. This is accomplished not only by pre-examination editorial review but also by statistical item analysis after the examination is administered.

For example, the author of a multiple-choice question may hold the following opinion of the 5 possible responses:
option 1—incorrect, easily recognized as such;
option 2—correct;
option 3—incorrect, easily recognized as such;

option 4—incorrect, difficult to distinguish from correct; and option 5—incorrect, somewhat difficult to distinguish from correct. From this description it would be expected that very few students would select options 1 and 3, that a larger proportion would select option 5, and that even more would select options 2 (the correct option) and 4; and actual results might than take the form shown in line A of Table 4. If, however, the results shown in line B were obtained, the author might suspect either that the students do not know the content or that there is some deficiency — some ambiguity — in the item itself. Any items found to be ambiguous by this post-examination review should be deleted from the examination before final scores and assessment symbols are assigned.

TABLE 4. ITEM ANALYSIS

Option	1	2	3	4	5
A. % students	2	58	4	25	11
B. % students	2	31	4	25	38

Consistency of results. Two general methods of assessing reliability (consistency) may be employed: repeated administration of the examination to see whether it assigns similar scores to each student each time (test–retest methods); and comparison of parts within the examination to see whether scores assigned to a student by one part are similar to scores assigned by other parts (internal consistency methods). For example, an examination with low reliability as determined by internal consistency methods might have several items that many of the better students (with high total scores) missed and the poorer students (with low total scores) answered correctly. Such an examination would be improved by deletion of these items before final scores are computed for the students.

Because it is important that both faculty and students can have confidence in the decisions made on the basis of an examination, it is essential that every examination be adequately evaluated. Any examination that fails to meet technical standards of adequacy cannot serve as a rational basis for decisions about student performance.

Step 7: report the results

The final step is that of reporting the results to all persons involved in the decisions being made on the basis of that examination. Exactly what is reported and to whom depends upon the purposes for which the examination was administered.

For example, the results of a diagnostic examination aimed at assessing a student's mastery of five content areas and his ability to perform three cognitive processes would be sent to the student and to his faculty adviser, showing a separate score and/or assessment symbol for each content area and for each cognitive process. This set of scores would then enable the student and his adviser to pinpoint specific weaknesses that warrant special attention. Because of the diagnostic nature of the examination, no report would be entered on the student's permanent record.

In the case of a certifying examination it may only be necessary to report the student's total score and its associated assessment symbol, since here the purpose is usually to record overall competence and not the specific components of competence. This information would be reported to the student and to the faculty committee responsible for certification and become part of the student's permanent record.

In any case, the contents of the reports and persons who receive them must be consistent with the purposes of the examination, to ensure that all relevant information is reported appropriately to all (and *only* those) persons entitled to knowledge of it.

ADDITIONAL READING

This paper outlines the basic issues involved in using examination data for decision-making but does not provide detailed explanations of the skills necessary for carrying out an examination plan. The following texts are recommended to those who wish to learn more.

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DYNAMICS OF A LEARNING GROUP

Shirley Perlmutter[1]

The knowledge explosion of the last 25 years has vastly increased the subject-matter to be taught in today's medical schools, and the demand for trained physicians has also accelerated. Medical schools are often understaffed and overextended, yet faculties must face students who have become increasingly vocal in demanding that classroom content be more relevant to the skills needed on the job. The medical school teacher of today finds himself facing a dilemma very much like that of the sorcerer's apprentice, whose every effort to stem the tide merely sent the waters higher. The purpose of this paper is to propose one way by which health professions teachers may be released from the demand that seems to be imposed by the unending growth of knowledge and heightened student expectations. To attain this goal, some of the assumptions underlying traditional teacher practices must first be examined in order to explore alternative approaches.

TRADITIONAL TEACHER BEHAVIOUR

Traditionally, the behaviour of teachers in medical schools has been characterized by a high degree of control over and direction of students, a posture presumably based on the assumptions that (1) if left to their own devices students would be apathetic about or resistant to the task of learning; (2) students do not know what they need in order to achieve effective professional performance goals; and (3) the teacher has the necessary expertise to determine the nature and scope of the subject-matter to be mastered. Thus it is commonly regarded as a

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faculty responsibility to motivate and direct students, to control their actions and influence their behaviour in such ways that the educational goals will be achieved. Teachers see themselves, and are seen by their students, as the experts who will present material and determine the extent to which students have mastered it. With the pressure of time and a constantly expanding factual content, teachers are rarely encouraged, or provided with the opportunity, to slow down and examine more closely the implications of these teaching practices for learning.

While this traditional approach to teaching is undoubtedly an efficient means of transmitting large quantities of information to large numbers of students, there is a real question of whether they grasp what is presented. It is also clear that such an instructional format produces students who are dependent upon experts for direction rather than independent in the pursuit of learning that must be lifelong. They come to believe that all expertise *does* reside in their teachers, and that performance should be judged by the expert standards that teachers alone establish. It should come as no surprise, then, that students are particularly concerned with how their behaviour is perceived by teachers, and express urgent needs to be directed, assigned specific tasks, and told that they are carrying out those tasks in the proper way. When deprived of these accustomed external sources of support and direction it is also understandable that they may experience considerable anxiety, if not frank hostility. And all this occurs in an atmosphere that is regularly described as impersonal and lacking in the important element of close interaction sought by both students and teachers.

A NEW FORMAT

As it becomes increasingly apparent that students can no longer be taught all they will need to learn, the focus of education must shift to teaching students *how* to learn and how to be independent, self-directed, and equipped to deal with an ever-changing environment. It has been said that if a student can be trained to be an effective and independent learner he need not be filled with all the information he can contain before going into a new job. He will have the capacity to learn whatever he needs to learn. Indeed, he will have to generate that capacity in any case, whether he is trained to do so or not, since no classroom can prepare him for every contingency, for every aspect of life and work encountered outside the classroom.

Training students to become self-directed learners implies a set of postulates about students and the learning process different from those described earlier. It assumes: (1) that each student enters the learning situation with an inherent desire to learn and a capacity to accept responsibility for his own learning; (2) that he has untapped resources that he may utilize to identify his own learning needs, assess potential learning resources available in his environment, and participate with teachers in determining the content to be mastered; (3) that significant and rapid learning will occur when he perceives the subject-matter as relevant to *his* purposes; and (4) that encouraging students to confront in an educational setting the kinds of practical problems they must face in the real world is one of the most effective modes of promoting learning.

One place in which to foster such independent learning is the small group. The idea of reducing class size to improve the quality of learning is not new. It has often been proposed in the hope that smaller numbers will allow more opportunity for student–teacher interaction, for the quiet and shy student to participate more freely, and for all students to become more actively involved with the content. But the expectation that a reduction in class size will bring about these changes is unrealistic. A one-way flow of communication from teacher to students can occur in a small group as well as a large one — and often does. If the potential of the small group (10—20 students) is to be realized fully, then traditional teaching behaviour must be modified to match the assumptions about students and learning listed above. In order to accomplish successfully this different teaching style, a teacher must be knowledgeable about the dimensions of the group process, the developmental stages of groups, and how to conduct himself in a manner that supports group development and the achievement of small group goals.

DIMENSIONS OF THE GROUP PROCESS

In order to avoid any possible misunderstanding it should be noted at once that group discussion is not intended to be random but rather to deal with some identified *content*. But whatever the content, all groups develop an operational *process* — a style of working together that has great impact on the quality of the product — and a set of relationships — patterns of interaction among the participants that affect the character of the experience. Whether the teacher recognizes them or not, these factors are at work, either facilitating or impeding the achievement of group goals. It is the teacher's task to be sure that the former, rather than the latter, is the dominant mode. If he is sensitive to this process he will give particular attention to (1) the amount of individual participation; (2) how members try to influence each other; (3) how group decisions are made; (4) how subgroupings are formed; and (5) how feelings are expressed.

In all groups, regardless of the purpose for which they have been formed or the nature of their participants, the process evolves through six general stages:

(1) Stage 1, *getting acquainted*, is characterized by polite and superficial interaction between the members. Even when they have met before, or even worked together, the formation of a new group creates an unfamiliar setting in which members must get to know each other anew.

(2) During stage 2, *What am I here for?*, members experience a period of ambiguity, a lack of direction or purpose. They become frustrated, angry, confused, and impatient.

(3) Out of this sense of disorder stage 3, *a bid for power and influence*, emerges. Members begin to attempt to create order out of what has become intolerable confusion. It is at this time that working rules for the group begin to be established and commitment to membership begins.

(4) In stage 4, *What can I do to help?*, group cohesion appears. Natural resources and leaders are identified and members negotiate around *who* will do *what*, and *when* to achieve the group task.

(5) Stage 5 is characterized by a *sense of accomplishment*. Through the negotiations that occurred during the stage 4 members are able to *collaborate*, to execute and complete the task.

If a group is formed for the purpose of accomplishing more than one task, each time a task is completed and another proposed the group will recycle through the first five stages. While the stage of *getting acquainted* may be less obvious the second time round, even this does occur. A new task usually creates the need for different resources and behaviours that were not required by the previous task. Thus as new tasks arise members must get to know each other in new ways.

(6) Finally stage 6, *termination*, occurs when the members recognize that at a specific time the group will come to an end and the participants will disperse. During this last stage (such as the final week of a 4-week workshop or the last month of a school year) members begin to disengage from the group and to reduce their involvement with and commitment to group issues. Some time may be spent in this stage reviewing events during the life of the group, in an attempt to summarize and put a closure to the experience.

One of the functions served by the model just outlined is that of providing a perspective for certain cyclic phenomena inherent in group work. For example, a let-down feeling and sense of disorganization often follow the "high" feelings associated with the sense of accomplishment in stage 5. This reappearance of "disorganization" is frequently interpreted as indicating poor group functioning, when it is in fact a natural phenomenon that recurs during the life of any group. The model also underlines the sequential nature of the stages and the importance of each. Even the period of ambiguity and chaos in stage 2 is productive. If members can tolerate some degree of frustration and uncertainty and refrain from prematurely organizing the group (stage 3), opportunities for potentially innovative and creative problem-solving around tasks will be enhanced.

CONDUCTING AN EFFECTIVE GROUP

In such small groups the ideal teacher is one who more often listens than talks, questions rather than answers, moderates rather than dictates, and stimulates others rather than performs himself. In such a setting the personal commitment to *learning* becomes overt and shared; both students and teacher can ask for feedback; personalized two-way communication can develop among students, and between students and teacher; and evaluation can be immediate, ongoing, and multidimensional from self, peers, and teacher.

In order to help readers to gain some concrete notion of how these principles can be translated into practice, a sequence of events is described below, illustrating how a teacher might facilitate the development of a climate that encourages self-directed and independent learning in the small group setting:

(1) The teacher opens with a description of his goals by presenting an overview of the objectives, the content to be mastered, and a proposed schedule of activities. Additional staff resources may also be introduced or otherwise identified.

(2) After this general introduction students are asked to describe *their* goals. These expectations are explored together through a problem census depicting individual learning needs.

(3) Teacher and students then compare the general programme objectives with the individual learning needs, noting similarities as well as differences.

(4) Learning needs identified by *both* teachers and students are translated into specific objectives and listed in order of priority.

(5) Teacher and students then identify jointly the objectives they can reasonably expect to achieve during the programme.

It is important that these five activities occur at the outset, in order to establish as a norm the active dialogue among sudents themselves as well as between students and faculty. The five steps assume that while the faculty has a set of general objectives and an instructional strategy to implement their achievement, there is sufficient flexibility in the programme to allow responsiveness to student input. This does not imply that students determine what will be taught but that the opportunity exists for shifting emphasis from one topic to another, for the inclusion of a related issue not originally planned, or for the elimination of something already learned, for example. It is also worth noting that the five steps correspond to the five stages of group development. The staff introduction and statement of goals *vis-à-vis* the student expressions of individual learning needs and expectations is a way for faculty and students to *begin to get acquainted* (I). The expression of individual learning interests and needs is often elaborate as well as diffuse, so that students and teachers alike may experience a sense of confusion (II) and of being overwhelmed (How will all this get done?). Comparing student and teacher goals, listing them according to perceived importance, is a way of *creating order* (III) out of the confusion. *Negotiating* (IV) a joint statement of goals also involves necessary collaboration (V).

This sequence, which generally takes 2–3 hours, illustrates the basic steps required to build a cooperative learning group. It may seem excessive in a class that meets for only one hour three times a week for a term, but the time invested in this way at the beginning will pay handsome dividends in the rapidity and solidity of subsequent learning.

But not all small groups enjoy the luxury of an extended period during which participants may work together; some may meet only once, and then for a short period. Yet even in the course of a single hour a skilful teacher may put into practice some of the principles that have been cited as critical contributions to productive group work and to the long-range goal of encouraging self-sustained independent learning. An illustration of such an effort, one that was created and tested by a participant in a recent teacher-training programme, is set forth in the accompanying table.

A teacher's primary concern, when he is trying to adapt small-group learning methodology to settings where the content is relatively fixed, is to devise a means of actively engaging students in the learning process. Even when time and content do not permit the group to evolve through all five stages, the model may be useful in identifying ways in which the learning activities may be designed to elicit maximum student participation.

For example, in the biodegradation exercise (see the accompanying

BIODEGRADATION — SMALL-GROUP EXERCISE*

Objectives: At the conclusion of the 1-hour session students will be able to:

(1) identify the reasons for modern sewage disposal;

(2) predict the effect on the ecology of a large lake of the release of a large volume of untreated or partially treated sewage;

(3) predict the possible effect on the health of a community of the release of a large volume of untreated or partially treated sewage in nearby water courses;

(4) evaluate data on the biochemical oxygen demand of a specified sample of water.

Design:

10 min — (1) Introduction.
Teacher introduces the topic and provides an overview of the hour.

15 min — (2) Class breaks into groups of 3.
Handouts distributed on Lake Erie ("Death of a Lake") and on gastrointestinal outbreaks.
Task - list the diseases spread via sewage
- understand the concept of biochemical oxygen demand.

(3) Return to full group — one member of each trio summarizes the deliberations under 2 above.

20 min — (4) Short lecture, illustrated with visual aids, followed by a discussion of sewage treatment.

10 min — (5) Class forms two groups of 6.
Handouts distributed on biochemical oxygen demand.
Task - to understand tests and interpret their significance.

(6) Return to full group.
Final summary and distribution of a synopsis of the session.

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figure) the teacher began with stage two. When he had identified himself as the authority with the intention of directing students to a specific topic, stage 2 was not an issue for the full group or the smaller groupings. The real group work was initiated with stage 3, when the class was divided into trios, each of which was required to designate a reporter. Stages 1 and 2 then occurred briefly as members began to

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know each other through the ways in which each responded to the task in hand, and as they sought to ascertain whether there was any residual confusion about the task. But the emphasis in stage 3 was on identifying resources within the group, so that they could progress through stages 4 and 5 to completion of the task. This sequence would then be repeated when groups of six were formed for the second task. Stage 6, *termination*, occurred when the groups reassembled as a full class for the final summary and distribution of a synopsis. But at every stage the focus was upon the students and their responsibility for learning, not upon the teacher and his opportunity to instruct.

CONCLUSION

Self-direction and independent learning are important general objectives in any programme of medical education, but this does not imply that even the most vigorous proponents of this stance advocate anarchy, in which every student does what he wants to do, any more than it is tolerable for every faculty member to do only what he wants to do without regard for others. There *is* a place for lectures and drill, for student listening as well as faculty talking. But if individual learning is to be optimized, faculty members must be prepared to exploit the principles outlined here, whether they are working with a few or with many students. It is, of course, more difficult with large numbers, but the teacher who accepts the fundamental validity of the assumptions upon which such an approach is based will find ways to incorporate those principles wherever he teaches. Subgrouping a large class to allow smaller numbers to engage even briefly in an active process of learning may seem a waste of precious time — but only if the teacher's role is seen as information source rather than learning facilitator. To the extent that they encourage students to find in their peers some of the stimulus and guidance that in conventional instruction depend upon teachers alone, they create an ever-widening group that can continue to provide mutual support in the act of learning independently and outside the classroom. And that, of course, is where it must occur for the rest of a professional career.

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TEACHING LARGE GROUPS

George E. Miller[1]

As higher education throughout the developed world has evolved from the privileged experience of a small elite to the reasonable expectation of a substantial segment of contemporary youth, a growing volume of complaints are heard about decline in quality of that experience as the number of students increases. Today, in developed and developing countries alike, those responsible for health professions education programmes are confronted with the problem that the social demand for trained professionals has dictated a substantial increase in student numbers in the absence of a proportionate expansion in what are believed to represent minimal resources of personnel and facilities. There is no faculty dissent from the demonstrable fact that large numbers of students can be processed through these educational programmes; their concern arises from the apparent impediment large numbers pose to producing graduates who have acquired not only the necessary body of information about health and disease but also the capacity to apply that information successfully in the management of the medical problems they must ultimately face, and the attitudes of personal responsibility for continuing their own self-education if the socially unacceptable alternative of professional obsolescence is to be avoided.

The issue is how to resolve the educational problem created by a discrepancy between large numbers of students and limited resources with which to train them. Rational analysis suggests three possible solutions:

1. *Reducing the number of students* is probably not a viable approach. It would be difficult to mount any convincing argument that large

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numbers decrease educational quality, for the limited evidence available suggests that class size is not the critical variable in the quality of individual learning.[1,2] In addition there is still too much to be accomplished in improving man's health, too much faith that this cannot be done without a substantial increase in the number of practitioners, and too much prestige associated with the physician role, to expect that society will reverse a trend that has won such widespread support.

2. *Increasing the resources* seems an equally unproductive path to pursue. This does not imply that medical schools have all the resources they need or that faculties should relax their efforts to acquire more. But the economic fact is inescapable that medical education is already among the most expensive of university programmes and there are other important claims on that portion of the gross national product of any nation that can legitimately be assigned to education or to health. There will certainly be continuing discussion of the issue of funding but it is unrealistic to expect an early solution to the problem of numbers as a result of a substantial and widespread increase in resources.

3. *Using the available resources differently.* Since the major resource in any educational enterprise is the faculty, whose members are surely capable of learning how to use themselves differently, this approach would appear to have the greatest immediate and long-term potential utility. The areas of teaching staff change that might be most fruitfully explored are: (*a*) altered perception of the teaching role; (*b*) the employment of different instructional strategies and tactics; and (*c*) the development of new instructional skills.

THE TEACHER ROLE

Medical teachers have generally won teaching appointments only after long study and the achievement of recognition as biomedical scientists or medical practitioners. Under these circumstances it is understandable that so many teachers should see their principal function as that of sharing with students the knowledge they have acquired, the skills they have developed, and the wisdom they have won. The teacher role thus becomes one of telling and showing, and the student role that of listening and watching until the teacher's learning has been transmitted.

[1] US Government Printing Office (1960) *Effectiveness in teaching. New dimensions in higher education, No. 2*, Washington, D.C.
[2] Sanazaro, P. J. (1966) Class size in medical school. *J. med. Educ.*, 41, 1017.

Such a role may be appropriate in a static field where final (or at least semi-final) truth has been established and the student task is simply one of absorbing fixed patterns of behaviour. It is surely not appropriate in a rapidly developing field where "facts" are always changing, new professional skills are constantly emerging, and the student's task is that of learning how to weigh and judge both the new and the old throughout his professional career. Here the teacher's responsibility is not to transfer his knowledge to students but to join them in a never-ending search for knowledge. In some instances what he has learned may prove useful to them, in others their challenges may prove useful to him, but in either instance the exchange is in both directions, not merely one way from authority to apprentice.

Many teachers who are intellectually prepared to accept such a role find it difficult to translate into practice. If they are not to engage primarily in showing and telling, what are they to do? Three major tasks can be clearly identified:

1. *Helping students to define the objective of a learning experience.* Anyone who has tried to "assist" a neophyte to learn anything knows how frustrating the work can be for both parties. The teacher who loses patience or fails to understand the purpose of the effort may respond too quickly when students cry, "just tell me what to learn and I will learn it." Only as a teacher comes to accept as his primary role that of helping students to learn how to learn, rather than to learn what he knows, will the interaction become both fruitful and satisfying. Once a student clearly understands the educational objectives in terms of his own career goals, his learning will generally proceed at a pace that astonishes both himself and his instructor.

"People learn what they want to learn" is an old aphorism too often overlooked by teachers who forget that their most important function is that of helping students to discover a need to know (i.e., the objective) — and then getting out of their way.

2. *Helping students to identify the available learning resources.* Among these resources are certainly individual teachers, but if there is honest acceptance of the principle that all knowledge does not reside in one teacher — or one department — then students will be helped to discover and use the many others that can be found on all sides. The most generally available resources are the printed materials collected in libraries, now increasingly supplemented by a growing array of other learning aids such as audiotapes, slides, films, videotapes, and programmed devices.

The problem is really not one of availability (although in some parts of the world the supply of books and journals may be limited) but of

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acceptance. Teachers who see their major teaching function as that of transmitting information often find it difficult to identify a source as accurate, as current, or as complete as their own knowledge, and thus are unable or unwilling even to recommend a textbook — unless they have written it. More consistent with the role highlighted here is the attitude of teachers who recognize the ever-changing nature of knowledge and are comfortable with having students learn things they may not personally accept — even things they may think wrong — provided that at the same time those students also learn how to make judgements and to defend with logic and reason the conclusions they have drawn. Such teachers will help students to see, appreciate, and use the infinitely varied learning resources a medical school provides, not merely the faculty member who stands before them.

3. *Providing students with non-judgemental feedback* on the extent to which they are achieving the learning objectives that have been agreed upon. The keyword in this phrase is "non-judgemental." To be sure, it is essential for quality control of education to make a judgement at some point of the extent of the individual student's learning, but the best evidence now available suggests that any student who has the intellectual ability required for admission to medical school is able to master its programme of study if given appropriate guidance and adequate time. The most important guidance function a teacher can fulfil is that of regular and systematic determination *with* each student of progress towards educational goals — a joint appraisal of what has been learned and what has yet to be learned, so that subsequent study can be directed towards filling the remaining gaps rather than further refining what has already been achieved. If such periodic, non-judgemental feedback is accomplished effectively, a student can face the ultimate judgemental assessment confident that he is abe to meet the minimum performance requirements.

Assumption of the teaching role described here and employment of the instructional strategies enumerated may demand a fundamental change in the attitudes of many teachers. Not least, there must be a willingness to accept students as responsible individuals who are able to learn independently and who need support more than instruction.

NEW INSTRUCTIONAL TACTICS

It is almost inevitable that, when encountered for the first time, the views set forth above will be interpreted as an attack on the lecture method of instruction. The removal of emphasis from "teaching" (in the sense of telling) and the placing of emphasis upon individual and independent learning certainly suggest such a conclusion. But it is important to draw a sharp distinction between the lecture *method* of instruction, and the lecture *system* of education. It is the latter, not the former, that must be discarded if the broad educational goals set forth in the opening paragraphs are to be achieved. A teacher who abandons the role of primary information source and accepts the role of learning facilitator may still use lectures but will use them sparingly and in a manner that serves goals more general than the transfer of information.

At the same time it must be acknowledged that in some parts of the world printed or audiovisual instructional materials in the native tongue of most students are virtually nonexistent. Here the alternatives seem to be: (*a*) the use of lectures or (*b*) the provision of printed information in a second language. Since books are often beyond the means of individual students the lecture system may thus by default become the dominant instructional mode, but such a system is attended by very serious hazards. Quite apart from the dependent learning habits that it encourages, anyone who has read carefully the literature on lectures will be appalled by the inaccuracies that occur as the lecturer's notes become the student's notes and by the serious limitation on information absorption that occurs after a relatively short time (15–30 minutes). Under these circumstances it is probably wiser for teachers to record their words for transcription in the native tongue or for playback by individual students or groups. This will at least introduce some measure of flexibility into the programme and an opportunity to use for other instructional purposes in later years the time that might be invested in repeating the same lectures. Despite the feeling teachers often have that lectures must be updated each year, the fundamental concepts to which such instruction for medical students should be addressed rarely change so rapidly.

But whether lectures are used as the principal method of instruction or merely as one element of a more varied instructional programme, the method can probably be used far more effectively than it is in most classrooms today. A change in dominant lecture style is especially important when the student body is large and opportunities for individual encounters with teachers are limited. A skilful lecturer can convey even to an audience of 500 some sense of personal interaction if he will avoid the impulse to tell all he knows, interrupt his discourse with concrete and relevant illustrations, and challenge his audience periodically to apply what has gone before or anticipate what is to come. The details of how to modify and improve lectures have been described elsewhere[1]; the purpose here is merely to remind readers that even this most widely used instructional method can be employed to serve more general objectives that are particularly significant if the problems associated with large classes are to be met successfully.

There are other methodological tactics that require no additional resources, merely a willingness to accept the new role already outlined. A simple illustration is the distribution of a clear and concise statement of learning objectives for a programme or course before instruction begins. Such a statement must be more meaningful than, for example, "to appreciate the importance of tranquillizers in the treatment of emotional disturbances". It must be couched in terms of what a student must do to ensure that both he and his teachers know that he has gained such appreciation. The methods of deriving and stating educational objectives have also been dealt with elsewhere[2]; it is the use to which they are put as instructional tools that is of concern here. Too often students are placed in the uncomfortable and frustrating position of having to guess the objective of an educational offering and waste untold energy in trying to anticipate what a teacher really wants them to learn (not to mention for what purpose). When the objective is both specified and shared in advance many students find ways to accomplish that learning in a manner more closely matched to a personal learning style than the faculty-designed method, and often in significantly less time. In the case of large groups, making such provision for individual differences is particularly important.

If it is also possible to provide a wide array of aids to independent study, so much the better. First among these are printed materials, available in such rich variety in so many parts of the world. More sophisticated instructional technology such as single concept films, audio-cassettes, programmed instructional devices, and simulations may have greater appeal but what is important is not the device itself but how that tool is used. Too often these aids to learning are regarded as add-ons, mere supplements to the conventional source of wisdom, the "teacher". If a new sense of personal responsibility for individual learning is ever to be achieved by health professions students, these instruments must be integral elements of a flexible and individualized programme, not merely extras to be enjoyed if time permits.

Among the most readily available, yet least used, aids to such an educational enterprise are the students themselves as teachers. Staff

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[1] Bughman, E. (1973) *The lecture method of instruction.* In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52) p. 52.

[2] Miller, G.E. (1973) *Educational objectives.* In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52), p. 26.

may not be prepared to acknowledge it, but the evidence is persuasive that a substantial amount of the most persistent learning that occurs in any educational programme results from peer interaction. Rather than allow this to take place in unplanned and random fashion, teachers who are willing to accept the primary role of guide might harness this vast potential to serve defined educational objectives. Encouraging the more advanced students to help the less advanced, the more senior to tutor the more junior, not only multiplies the instructional resources of an institution but also provides those who teach with an unparalleled opportunity to further their own learning. A fifth-year medical student may not be able to provide for a second-year student the depth of instruction in biochemistry that a biochemist would offer, but the communication is more likely to match the learning readiness of the novice. It will at the same time crystallize his own understanding of the topic, for in the most succesful teaching/learning exchange the teacher profits quite as much as the taught. Such factors should encourage the utilization of students as teachers in any setting; where classes are large, the further advantage of reducing the size of learning groups, through increasing the number of teachers, is also achieved.

While peers may provide the most readily accessible pool of additional teaching talent there are others, rarely used, from whom health professionals can also learn: the practitioners of these professions. So long as the teaching role is regarded principally as that of information source it is understandable that academics at the frontiers of a discipline are reluctant to entrust students to practitioners who are not always "up to date." But if the teacher becomes a guide, one who helps a student to identify what he needs to learn and who provides opportunities through which that learning can occur, then practitioners can become important contributors to this effort. What they have to offer may also be considerably closer to the career for which most students are preparing than the contributions of academic specialists, who now play the dominant role in most programmes of medical education.

Finally, if such non-traditional activities are to further the most effective learning and the most efficient use of learning resources there must be some ongoing mechanism for students and faculty to assure themselves that learning is being accomplished. It is here that the diagnostic examination fulfils such an important function. Students everywhere have been conditioned to perceive examinations as a threat to their academic survival, and unfortunately too many teachers still use examinations in a manner that justifies such a conclusion. It may take time, and will certainly require that teachers behave more in keeping with the role of facilitator rather than judge, but with these provisos there is no reason to doubt that students can be brought to the point of seeking out diagnostic examinations to help them define more precisely both what they have learned and what they have yet to master. The mechanisms for implementing such a programme have been dealt with at length elsewhere[1] and need not be repeated here. But it may be important to emphasize that accomplishing the aim of increasing individualization of learning opportunities for large classes is unlikely unless there is some provision for regular, personal, non-judgemental feedback of learning achievements and remaining deficiencies.

NEW SKILLS

Even teachers who are persuaded that they must accept a new role and are willing to try new instructional methods will probably discover that their preparation has not provided the necessary skills for conducting educational programmes so different from those they have known. In fact, there is little hope that what has been outlined here can be achieved unless teachers are willing to develop new pedagogic skills and further refine some they may already have acquired (e.g., developing greater proficiency in delivering lectures).

Among the most vital is the skill of educational planning. It is probably no exaggeration to say that most medical teachers now develop an educational plan on the basis of subject-matter content. Either through personal experience with the field in which they are expert or through the guidance provided by standard textbooks, they decide what must be taught, and in what sequence. But the goal of education is learning, not teaching; and the distinction is more than semantic: learning implies a change in behaviour, not merely exposure to instruction. Thus educationalplanning must begin with clear delineation of what students should be able to *do* at the conclusion of a course of study, after which the knowledge they need can be more rationally defined. Since the primary purpose of health professions education is to produce practitioners who are able to promote the health of society, this definition will relate directly to the health of the community they are to serve. The derivation and specification of objectives, and the mechanism for their incorporation into educational programmes, has also been described elsewhere[2, 3]; it is to these descriptions that teachers

[1] McGuire, C.H. (1973) *Diagnostic examinations in medical education*. In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52), p. 59.

[2] Miller, G.E. (1973) *Educational objectives*. In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52), p. 26.

[3] Pochyly, D.F. (1973) *Educational programme planning*. In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*. No. 52), p. 17.

ready to acquire new skills for dealing with large classes may wish to turn for further guidance.

Obviously, if individualized instruction is to be made available to a large body of students it will be necessary to produce or to select many new aids to learning. The means of accomplishing these goals have also been described.[1] It is important to insert a cautionary reminder here. The purpose is not merely to develop new materials that exploit the mechanical potential of a growing array of simple and complex devices, it is to facilitate learning. Tools have no value in and of themselves. If they are misused their potential to impede learning may be realized. Thus in this arena the skill that teachers must acquire is not only one of *developing* suitable materials to aid learning, but also of *using* them appropriately as an integral element of a total learning system.

Most important, however, may be the ability to provide individual students with the encouragement, guidance, and support they need in order to learn most successfully. Although such skills are important in any educational environment they become critical elements in a programme that must accommodate large numbers of students and where the opportunities for individual or small-group exchanges between teacher and student are so limited that each encounter must be maximally effective.

The techniques for organizing and moderating small-group discussion have already been dealt with.[2] Rather than repeat here what has been said more fully there, only three items will be mentioned that seem to be central to the dialogue which, to facilitate learning, must encourage students to disclose their ignorance, assist them to discover a need to know new things, and acknowledge the achievements that they demonstrate. In order to accomplish this a teacher must develop a high level of skill in questioning thoughtfully, listening perceptively, and responding supportively.

It may seem strange that the first of these skills is questioning, since quizzing is already extensively used in educational programmes for the health professions. It is important, however, to focus upon the difference between *interrogation*, which is certainly widespread, and *inquiring*, which is far less commonly practised. One takes the form of a catechism, where question and answer match a predetermined pattern and substance; the other takes the form of exploration, in which question and answer are the beginning of a search, not its end. In the former a teacher sets the questions and the student is expected to

[1] Penta, F.B. & Telder, T.V. (1973) *Audiovisual aids to learning*. In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52), p. 40.
[2] See p. 46.

provide correct responses, while in the latter a teacher may set the stage for questions but does not set the limits. The interrogator is interested primarily in assessing the knowledge a student has acquired; the inquirer is more concerned with identifying how he can be helpful in furthering a student's learning. Where the former, following a specific reading assignment on perforated peptic ulcer, might ask "What are the signs and symptoms of...?", the latter would ask "What still puzzles you about...?". The interrogator seeks facts, the inquirer looks for reasons.

The second critical element is the skill of listening. It must be surprising to any objective analyst of formal education to discover how completely the process is dominated by teachers talking, as though listening were equivalent to learning. Communication is the keystone upon which the educational arch is built, but to be effective the flow must be in two directions. This requires teachers not only to be quiet at more than infrequent intervals but also, by thoughtful listening and inquiring response, to encourage students to question and challenge as fully as they are being questioned and challenged. The skilful listener is also sensitive to messages communicated by more than words—to the non-verbal expressions that may signal anxiety, hostility, lack of interest, or preoccupation with other things—and will use these data, as well as the words, in fashioning a response. Students may prefer to avoid what is not verbalized, but the purpose of the interaction is not to do what they want but to do what is necessary to facilitate their learning.

The supportive skill thus comes into focus. Support is provided by encouragement and approbation, which should be given sincerely and as often as is justified. But support is also provided by revelation and critique offered with kindness and without judgement. Few students want their deficiencies highlighted and it is particularly regrettable that few faculty members are skilled in accomplishing this necessary task in a manner that is perceived as helpful rather than censorious. To provide critique without conveying negative criticism is the goal, for the one fosters further learning while the other merely arouses a defence reaction. Until a teacher acquires this skill his effectiveness in the role of educational counsellor and guide will always be limited.

CONCLUSION

The problem of large class size, which is encountered in so many medical schools in both developed and developing countries, is unlikely to vanish in the foreseeable future and the associated educational problems are unlikely to be resolved by the massive infusion of new resources. The most realistic approach to the question seems to be that of using differently the resources now available, and particularly the most critical of these—the teacher.

While this paper has drawn attention to a different role, alternative educational strategies, and refined pedagogic skills that individual teachers can employ to increase their effectiveness in dealing with large numbers of students in a more individualized manner, no concrete proposal for altering curriculum organization has been made, since structure seems less important than the process by which learning is

FACULTY MAN-HOURS REQUIRED FOR A 20-WEEK BASIC SCIENCE COURSE FOR 300 STUDENTS

	Conventional organization		Non-traditional organization	
	Senior staff	Assistants	Senior staff	Assistants
Lecture (full class)				
delivery	100		20	
preparation	200		40	
Laboratory[a]				
delivery	80	320		50
preparation	40	160	20	100
Independent study[b] (identification and preparation of materials)			80	190
Individual conference[c] (office hours)			100	200
Small-group work[d] (30 per group)			100	
Total man-hours	420	480	360	540
	900		900	

[a] Laboratory—4 hours per week, 5 laboratory groups in a conventional programme. Laboratory available at scheduled hours for students' use, staffed by assistants only in non-traditional organization.
[b] Time necessary to identify or prepare texts, articles, or self-testing devices for students to use independently at home, in the library, in the laboratory, or in the classroom.
[c] Provision for each student to have two 30-minute individual conferences during the 20-week course.
[d] Provision for one-hour small-group conference every other week for each group of 30 students.

facilitated.[1] But structure can impede that process and the accompanying table offers an illustration of how a specific lecture/laboratory programme for 300 students might be modified to achieve the goal of greater individualization without any change in the amount of faculty time devoted to the educational tasks. There is ample evidence to support the view that such practices are effective.[2] The question of whether teachers are willing to adopt them cannot be answered with a comparable degree of confidence. Unless they do, however, it is unlikely that the educational problems of teaching large groups will ever be solved.

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[1] Rodin, A.E. & Levine, H.G. (1973) *J. med. Educ.*, 48, 349.
[2] Postlethwaite, S.N. (1965) *Plant science: a workbook with an audio program approach*, Minneapolis, Burgess.

THE EVALUATION OF TEACHERS AND TEACHING EFFECTIVENESS

Christine H. McGuire[1]

Fundamentally, the goals of education are not unlike the goals of therapy, i.e., to facilitate optimum functioning of the organism. Hence the methodology for evaluating teachers and teaching is, in essence, analogous to that employed in evaluating any other therapeutic agent, and the pitfalls of research in this area parallel those in any field of clinical research.

A DESCRIPTION OF CURRENT APPROACHES

The three approaches to the evaluation of teachers and teaching that are currently most widely employed and that appear to hold the greatest promise can be distinguished in terms of the primary object towards which assessment efforts are directed: *perceptions*, *process*, and *product*. As shown in Table 1, each approach has its analogue in clinical research and, like the latter, its characteristic data type and source. The methods of collecting these data, their interpretation, and their limitations are outlined below. In this brief synopsis, discussion is limited to a definition of the approach and the identification of the question or questions each is designed to answer.

Assessment of learner perceptions

Although the oldest, this approach is still widely used and very commonly misused. It is designed to answer the question: "How did students feel about the quality of the teacher, the teaching, and the programme?" Formal or informal student reactions and/or ratings

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TABLE 1. APPROACHES TO EVALUATION OF TEACHERS AND TEACHING

Approach	Data source	Clinical equivalent
Assessment of perceptions	Reports of student reactions	Evaluation of patient's subjective feelings
Assessment of process	Observations of student-teacher interaction	Evaluation of therapeutic rationale on patho-physiological principles
Assessment of product, outcome, or effect	Tests of student performance	Evaluation of therapeutic efficacy

constitute the data for answering the question. Typically, these data are collected by interview and/or questionnaire that may range from highly structured to completely open-ended inquiries. These may be couched in a form that invites the student to comment directly on his reactions, or in a form that induces him to respond to a series of indirect probes in a manner that reveals reactions about which he would be less able or less willing to be candid.

Assessment of process

In contrast to the assessment of perceptions, which deliberately seeks *opinions about the merits* of various elements in the instructional programme, process assessment is designed to determine *what actually occurred* in the encounter between teacher and learner. The basic question that it attempts to answer is: "What was the nature and quality of the setting and of the communication (interaction) between student and teacher?"

The information needed to answer that question is simple descriptive data obtained from systematic, impartial, skilled observation of the teacher and the learner in the instructional situation. Since, however, there is an unmanageably large number of attributes of the learning situation (ranging from the temperature of the room to the "heat" of the student—teacher exchange) on which observations could be made, it is necessary to select those characteristics likely to be most important in facilitating or inhibiting achievement of the desired outcomes. This decision is, at least implicitly, based on a theory of learning, and thus the observations made are, in fact, designed to answer the question: "To what extent does the teacher create an environment in which the actual conditions for learning are congruent with those that a selected theory of learning asserts as optimal?"

Assessment of product

Whether a recommended set of conditions for learning is, in fact, optimal can be determined only by examining their consequences. It is to this issue that the assessment of educational product or outcome is addressed. All product assessment is designed to answer the question: "To what extent is the educational agent effective in accomplishing the educational goals?" If it is true that teaching is undertaken mainly for the purpose of producing student learning, it follows that teacher effectiveness must ultimately be assayed in terms of the extent to which this intended outcome is achieved, and teacher efficiency judged only after the costs are documented and charged against the changes in student knowledge, judgement, skills, habits, and attitudes that are realized.

Two types of data are therefore indispensable in answering the question posed in this approach: those derived from comprehensive measures of relevant aspects of student performance, and those obtained from careful cost accounting of teacher and student time expended, other resources consumed, and undesired side effects induced in the educational programme.

THE METHODOLOGY OF CURRENT APPROACHES

Assessment of perceptions

The basic data on student satisfaction are variously obtained: some institutions employ a standard *rating form* in which students evaluate an instructor or a course, ranking each in relation to others he has known; other institutions use a more detailed *questionnaire* designed to elicit candid reactions to multiple elements (e.g., a particular lecture, the required text, tutorial hours, etc.) of the instructional situation. With respect to each, students may be asked to indicate what they liked or disliked and the intensity of that feeling, what was found valuable or useless, what experiences they would prefer to have expanded or reduced, and the like. Both rating forms and questionnaires are often combined with a third type of student reaction form designed to probe specific feelings that actions of the instructor have evoked. In general, such questions (illustrated in Fig. 1) are selected on the basis of contemporary learning theory and represent those aspects of the student–teacher relationship thought to influence the efficiency and effectiveness of learning.

Data collected from the ratings, questionnaires, and other reaction forms are summarized to show general tendencies in student evaluations.

FIG. 1. EXCERPTS FROM A STUDENT REACTION FORM

Did you feel free to challenge the instructor when you thought something he said was incorrect? Yes ...... No ......

Did you feel free to ask the instructor a question about something you did not understand? Yes ... No .

How often were you stimulated to think about additional applications of concepts and principles the instructor was discussing? Practically always . . Occasionally . . . Rarely .... Never ......

Did you find that the instructor was sufficiently flexible in modifying his plans to suit your needs? Yes .... No ....

When possible, responses are correlated with intellectual and personality characteristics so as to enhance their usefulness in faculty efforts to individualize instruction.

Process assessment

Broadly speaking, two quite different rationales and associated methodologies characterize most forms of process assessment: (1) analysis of the conditions for learning samples the elements that characterize the total learning situation; (2) interaction analysis focuses only on those elements (primarily verbal) that characterize teacher behaviour and/or student—teacher interaction.

An *analysis of the conditions of learning* begins by identifying as concretely as possible the outcomes sought in a particular instructional situation — a course, a lecture, a seminar, a laboratory, ward rounds, and the like. For example, the general outcome of "developing skill in physical examination of the patient" could, if specified by a detailed

FIG. 2. SELECTED PRINCIPLES OF LEARNING RELEVANT TO THE LEARNING OF A SKILL

Learning tends to be more efficient when the objectives are clearly understood by the learner.

Learning of a skill is facilitated by frequent, brief practice periods spaced over an extended time period.

Prompt, specific feedback that enables the learner to identify errors in his performance facilitates the learning of a skill.

Prompt, specific feedback that reinforces correct elements of a performance facilitates learning.

definition of the components of that skill, be used as the starting point. Once the desired outcome has been determined, the next step must be to identify the learning principles that apply most directly to the specified learning goal. For the illustration given above, the principles stated in Fig. 2 would be among those isolated for consideration. Using such principles as a frame of reference, an evaluator then proceeds to construct a highly structured questionnaire, interview, or observation form that will yield objective, descriptive data about the extent to which the specified conditions are met in the actual situation. An excerpt from such a form, developed for the illustration cited above, is shown in Fig. 3. Note that, with minor changes, the questions listed there could be employed as a checklist by an observer, as an interview schedule by a trained interviewer, or as a structured questionnaire for direct distribution to students. In whatever mode they are employed, the two essential elements are: (1) that each question be derived from a

FIG. 3. EXCERPT FROM A FORM DESIGNED TO ASSESS THE CONDITIONS FOR LEARNING A SPECIFIC SKILL

Were the objectives of the course (the instructional unit, the instructional exercise) explained to the students?

What is the evidence that these objectives were actually understood by the students?

How much opportunity did the students have to practise each manoeuvre involved in the physical examination of the patient? How frequently were these practice periods scheduled? When (in relation to the relevant didactic material) were they scheduled? How long was each practice period? Were variable opportunities provided to students in accordance with individual differences in proficiency?

How often did the instructor actually observe the student examining a patient?

Did the instructor provide any feedback to the student on the accuracy of his findings? If yes, when was the feedback provided? In what form was it provided?

Did the instructor provide any feedback to the student regarding his technical skill in eliciting these findings? If yes, when was this feedback provided? In what form was it provided?

principle of learning that is relevant to the educational outcomes sought; and (2) that each question be formulated in a manner that will yield objective, descriptive information, not opinions or preferences.

Finally, it should be noted that, since communication of some kind is inherent in any instructional situation, assessment of the conditions for learning will also include at least a few generally applicable questions that yield data about the basic characteristics of the communication. This evidence would be derived from such questions as, for example: "Could the speaker be heard by all parties to the communication?"; "Did he use terms that were understandable to his listeners?"; "When introducing a new term did he define it?"; "Were abstract concepts illustrated with concrete examples?"; "Conversely, were specific bits of illustrated with concrete examples?"; "Conversely, were specific items of information and data related to a general frame of reference?"; "What variety of media was used to supplement the spoken word?"; Responses to questions such as these yield the necessary data for determining whether the most elementary requirements of the communication process have been met, and thus whether there is some probability that communication has occurred.

In contrast with the approach described above, the various forms of *interaction analysis* focus exclusively on the nature of the communication process. This is accomplished through detailed, systematic analysis of the behaviour (predominantly verbal) of teacher and/or students. Originally developed for use in a formal classroom situation, most forms of interaction analysis are also useful in other instructional settings. Some adherents of this technique (e.g., D. G. Ryans, B. O. Smith[1]) focus attention primarily on teacher behaviour; others (e.g. R. F. Bales, N. A. Flanders and E. J. Amidon[2]) use the method to examine the quantity and quality of interaction between teachers and students.

Irrespective of the precise emphasis, the general methodology is similar for most variants of this approach. Specifically, observers are trained to record at specified intervals (e.g., every 3 seconds), on a form (such as that shown in Fig. 4), the nature of the verbal behaviour then occurring. These recordings are made for predefined periods (e.g., 10 – 15 minutes) and the periods are selected to sample different points (e.g., the beginning, middle, and end) during an instructional session or during several sessions extending over a school term. The recordings are then summarized and analysed in terms of such variables as percentage of teacher talk as compared with students talk, percentage of teacher talk in each behavioural category, percentage of student talk in each category, characteristic sequences of teacher – student behaviour, and the like.

Certain proponents of this approach define the variables to be observed in strictly behavioural terms (as in Fig. 5) in a manner that requires the observer to make only minimal interpretation. Others, in

[1] Pi Lambda Theta (1967) *The evaluation of teaching*, Washington, D.C., Banta.
[2] Amidon, E. J. & Hough, J. B. (1967) *Interaction analysis: theory, research and application*, Reading, Mass., Addison-Wesley.

FIG. 4. EXCERPT FROM A FORM FOR RECORDING STUDENT - TEACHER INTERACTION

INSTRUCTIONS Using the symbols shown below, make a notation every three (3) seconds for ten (10) consecutive minutes to indicate the nature of the behaviour occurring at each three-second interval.

LEGEND **Teacher behaviour:**

1 = asks a question
2 = gives instructions
3 = provides information
4 = reflects student comment
5 = etc.

Student behaviour:

6 = asks a question
7 = answers a question
8 = provides information
9 = etc.

Other:

10 = silence
11 = etc.

Date: .. Hour: . . Class: .. .

Instructor: . . . . Observer: .. . .

First recording-time :

an attempt to get at more dynamic elements in the interaction and to identify potentially facilitative and inhibitory roles played by each participant, include such terms as "clarifies", "summarizes", "obstructs", "expresses hostility", and "challenges" in the list of behaviours that the observer is to record. Inclusion of such terms requires more interpretation of the observed phenomena, introduces greater subjectivity into the observations, and imposes the need for more extended training of observers, in order to achieve acceptable levels of inter-observer reliability. However, irrespective of the specific categories of teacher and/or student behaviour selected for recording, this approach is explicitly limited to observation of the interaction process *per se*; no attempt is made to relate that process to objectives or to outcomes, either directly or indirectly through general learning theory.

Product assessment

In contrast, product assessment in its pure form is concerned exclusively with *objectives* (product sought) and *outcome* (product realized), and thus requires that the goals of the educational programme be clearly specified, that they be defined in terms of behavioural changes to be brought about in the learner, that test situations be designed to sample these behaviours, and that these test situations be administered to the learner to determine whether he is able to perform in the desired manner and at the prescribed level of competence.

The techniques used to assess performance range from conventional tests of information, through sophisticated simulations of clinical problems, to long-term, systematic observations of the learner in varied professional settings. These techniques, extensively described elsewhere,[1] do not differ in kind from those regularly employed to certify student competence. Only their scheduling and the method of summarizing their results need be modified when performance tests are administered to students for purposes of teacher, rather than student, evaluation. Since in the former case the emphasis is on the *change* brought about in the behaviour of the learner, it is necessary to administer the same or comparable tests at the beginning and again at the end of the instructional period under scrutiny. Further, if long-term effects are included in the objectives of the programme, a complete evaluation requires follow-up data regarding subsequent performance of the learners.

Just as the timing of any assessment is determined by the purpose for which it is made, so must the method of summarizing the data be dictated by the purpose for which they are collected. In certifying student competence it is adequate to report merely whether the student does or does not meet the required performance standards. For programme evaluation it is also important to know how many students do or do not meet each of these standards. Indeed, if large groups persistently fail to meet any of them this is a clear sign that something is wrong somewhere — in the teaching, the students, the test, or the standards. However, for purposes of evaluating teaching such a summary is insufficient.

To serve this purpose the performance data must be presented in a manner that helps to answer the following questions: (1) How much *gain* was made by the total and by relevant subgroups of students?; (2) What are the characteristics of the students who appear to gain

[1] See Charvat, J. et al. (1968) *A review of the nature and uses of examinations in medical education*, Geneva, World Health Organization (*Public Health Papers*, No. 36).

most (or least) from the current instructional programme?; (3) What are the *specific areas* (e.g., concepts, skills, professional demeanour) of greatest and of least gain?; (4) What *specific* misconceptions (or other forms of inadequacy) are still relatively common among students at the end of the instructional programme?

Clearly, conventional student performance reports showing the distribution of scores at different points in time yield very little evidence that is useful in answering such questions. Only detailed item analyses of the results of each administration of the performance tests will suffice. Such analyses can be designed to report the number ot students in each group and each relevant subgroup who give each possible response and who make each type of error, and the changes over time in this performance pattern. Such information is particularly valuable when supplemented by various item statistics that report the correlations between each response and appropriate criterion variables, and between each response and relevant student characteristics and/or programme or instructional variables. Techniques of summarizing performance data in this manner are explained in standard texts on test analysis.

No product evaluation is complete without *cost analysis*, particularly since evidence is mounting that, given adequate time, personal instruction, and self-instructional resources, virtually all students of normal intelligence and emotional stability can master almost any element among the objectives of higher education. The issue therefore becomes an economic one of determining whom a country can afford to educate and at what level of mastery, i.e., at what cost in resources. Given the enormous attention currently devoted to the economics of health care delivery, it is astonishing how little consideration is being given to the economic issues of health professional education. Most presently available data are deficient on two counts: (1) they are chiefly retrospective; and (2) the data categories are defined in such gross terms that it is usually impossible to allocate costs along genuinely functional lines.

In order to evaluate teaching and teachers in cost—benefit terms, a detailed recording of the amounts of all resources that go into any instructional effort is urgently needed. If we are to avoid the notorious unreliability of retrospective data, this implies investigating representative samples of students and faculty to determine how much of their time is actually devoted to some kind of instructional activity, the exact nature of that activity, and the way in which the quantity and distribution of such activities change with different instructional methodologies. It also suggests the importance of costing out other elements in the instructional situation, such as, for example, the additional laboratory and hospital costs where patients are used as "teaching material". At present the only usable data tend to be those concerned with the direct money costs attributable to the construction and maintenance of specialized facilities (e.g., lecture halls, student laboratories) and materials (educational films, slides, self-instructional programmes).

In the absence of hard facts, it is difficult to escape the suspicion that, because their costs are hidden, we continue to cling to traditional methods that are not only ineffectual but may also be inexcusably uneconomic, for they rely on the most costly resources of all—professional time and patient disability.

USES AND LIMITATIONS OF CURRENT APPROACHES

Since, if properly interpreted, *some* data are usually better than *no* data, it could be argued that the primary limitation of all current approaches lies in their inadequate usage. However, each one also has certain additional shortcomings that must be assessed if serious errors in interpretation are to be minimized.

Assessment of perceptions — the fallacy that truth is in the eyes of the beholder

Clearly, when perceptions are used as the primary data for evaluating teachers or teaching, there is always the danger that student reactions will be interpreted as if they were statements of *facts*, rather than highly subjective, individual, and variable *opinions*. Thus, when a student says: "The programme was very valuable; I learned a great deal," there is a natural tendency to believe this to be so. Unfortunately, there is no evidence to support the view that enjoyment, satisfaction, hard work, or any other reported "positive" reaction is necessarily correlated with learning. On the other hand, there is also no evidence to support the view that something distasteful (either medical or educational) is necessarily "good" for the recipient. Nonetheless, *provided* the data are properly interpreted as simple statements of consumer satisfactions and dissatisfactions, the assessment of teaching through student perceptions can (1) assist in the diagnosis of some causes of inadequate achievement; and (2) contribute to the identification and creation of conditions that will enhance motivational and other affective responses that facilitate learning.

Assessment of process — the fallacy that fads and fetishes produce results

The history of therapeutics is replete with examples of interventions earnestly advocated and consistently employed by one generation of physicians, only to be proved useless or even harmful by a subsequent generation. Widespread adoption of the current "treatment of choice", in the absence of supportive data about its relative efficacy, epitomizes the pitfalls of a preoccupation with process assessment, independent of product assessment. For, like therapeutics, education is a victim of process fads.

While educational science has been successful in demonstrating that teachers are intolerably costly and inexcusably inefficient purveyors of information, or dictators of concepts more accurately recorded in readily available literature, it has unfortunately not been so successful in defining the teacher's role positively. Repeated experimental studies of the relative effectiveness of varied instructional methodologies — lecture, discussion, programmed instruction — have produced conflicting evidence and inconclusive results. It may have been naive to expect any definitive outcome from experiments that, on reflection, appear to represent a simplistic search for an educational panacea — a pursuit no less futile than the quest for an all-purpose, miracle drug.

In rejecting the role of lecturer and accepting the view that mature students are responsible for their own learning, however, some teachers have gone through what can only be described as an "identity crisis". In this anxious state many have abdicated all responsibility for defining objectives, planning the educational programmes, creating appropriately stimulating conditions and adequately varied resources, setting standards of student performance, and gathering the requisite data for ensuring that students meet those standards. Regrettably, there has been little evidence that adherents of the newer and more sophisticated forms of process assessment have attempted to solve this identity crisis by utilizing their potentially powerful tools in systematic studies of the relation between teacher behaviour and student achievement.

Until the basic connexions between process and product are established, the utility of process assessment must remain limited to research, training, and diagnostic applications. As a research tool, process analysis opens up the opportunity of determining the relative effectiveness of alternative elements in teaching strategies; as a training tool it enables the teacher to hold a mirror to his performance and to determine the extent to which his actual conduct was a true reflection of his intended strategy; as a diagnostic tool, process assessment, when used in conjunction with product assessment, yields data that may be of value in suggesting alternative hypotheses to explain actual outcomes that fall short of intended outcomes. At this stage of educational development, process assessment *cannot* be used in direct evaluation of teachers and teaching effectiveness; it can best be used only in conjunction with other methods to assist teachers in improving their performance.

Product assessment — the fallacy of confusing concurrence with causality

Although product assessment furnishes the only data that are directly relevant in the ultimate evaluation of teaching effectiveness, it also presents the greatest difficulties in fundamental study design, for four reasons: (1) all the factors that normally confound any research on human subjects are present in all studies of educational outcome; (2) the study population is never randomly selected and its small size and lack of comparability with other populations undergoing alternative educational treatments make generalization hazardous, even when conventional statistical safeguards have been applied; (3) the teaching being evaluated usually constitutes such a small proportion of the total educational influences operating on the student subjects that it becomes almost impossible to establish plausible causal linkages; and (4) the usual controlled experiment (even less, the double blind) design is rarely feasible and almost never suitable. Indeed, Glaser asserts that the tyranny of the controlled experiment has probably done more to retard educational progress than any other single influence. He bases this conclusion on the observation that the only issues that can be studied by this method are so trivial that they are hardly worth the effort, that the findings are available only at a point in time when they are useless for decision-making, and that the requirements of the design are such that the conditions to which the findings apply can rarely be duplicated.

In addition to these inherent limitations, product assessment imposes one additional hardship on the conscientious evaluator: the necessity of estimating *all* elements of the product that are relevant to a particular instructional programme. Addressing a very limited range of objectives (e.g., increase in factual knowledge) continues to be one of the most common failings of studies utilizing this approach.

Given such severe limitations, it may appear that product assessment is of little practical utility. However, at the same time, it is the one indispensable approach to the evaluation of teaching. This apparent paradox is readily explained: although it may be impossible to establish by this method that a given strategy is responsible for success, it is the only method by which failure to achieve the goals of teaching can be documented and the warning clearly sounded that "something is wrong". Other approaches can then be employed in the effort to identify and remedy the deficiency.

CONCLUSION

Dissonance between the results yielded in the assessment of product and those obtained from the assessment of process and perceptions is sufficiently common to impose the necessity of collecting a variety of types of data as a basis for making inescapable decisions about the effectiveness of teaching. Three approaches to the evaluation of teaching have therefore been described as sources of the required data The methodology of each has been presented, together with a discussion of its utility and its characteristic limitations. In the light of these limitations a combination of all three approaches is recommended as indispensable.

ADDITIONAL READING

Amidon, E. J. & Hough, J. B. (1967) *Interaction analysis: theory, research and application*, Reading, Mass., Addison-Wesley
This book of readings with chapters by leading authorities describes in detail the philosophy, rationale, and methods of conducting, summarizing, analysing, and interpreting the most widely used forms of interaction analysis.

Pi Lambda Theta (1967) *The evaluation of teaching*, Washington, D.C., Banta
A compendium of chapters by authors who advocate different approaches to the evaluation of teaching. The chapter by McGuire will be found useful as a review of the total scope of the problem; the chapters by D. G. Ryans and B. O. Smith elaborate their respective approaches to the study of teacher behaviour as discussed in this paper.

Charvat, J. et al. (1968) *A review of the nature and uses of examinations in medical education*, Geneva, World Health Organization (*Public Health Papers*, No. 36)
Chapter 4 provides a succinct summary of new techniques for product assessment and a description of certain approaches to process assessment other than interaction analysis.

Gage, N. L., ed. (1963) *Handbook of research on teaching: a project of the American Educational Research Association*, Chicago, Rand McNally
Only for the reader who desires a comprehensive, sophisticated discussion of the merits and limitations of alternative research designs. That reader will find this volume an extraordinarily valuable resource in suggesting alternative solutions to the problems of research design in this area.

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MICROTEACHING FOR TEACHER TRAINING

Richard P. Foley[1]

In response to student dissatisfaction with traditional modes of training, medical educators everywhere have been engaged in thoughtful examination of faculty training programmes, since it has become increasingly evident that more systematic and economical methods are needed for evident teachers to acquire increased pedagogic skill.

One alternative to present teacher-training methods that has been widely applied by educators from other disciplines is *microteaching*. It is the purpose of this paper to describe the technique conceptually and operationally, and to offer suggestions for the incorporation of the method into the programmes of schools for the health professions.

MICROTEACHING: A DESCRIPTION

A graduate student in microbiology holds up an agar plate before four first-year medical students to demonstrate its use in isolating bacterial colonies. Fifteen feet away, a professor of microbiology who is supervising the teacher aims the camera of a videotape recorder at the group and occasionally writes down some notes. Although the teaching lasts for only 10 minutes, two significant things happen. The medical students have had an opportunity to learn one method for isolating bacterial colonies, and the teacher has had an opportunity to practise the instructional technique of presenting a laboratory demonstration. After the presentation is concluded, the supervisor asks each student to fill in a questionnaire regarding the teacher's performance. The students then leave the room and a 15-minute critique follows in which the supervisor and instructor discuss the demonstration, review

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the written comments of both supervisor and students, and view segments of the videotape. After a short break, during which the practice teacher has the opportunity to incorporate suggestions from the critique, the entire process is repeated with a different group of medical students. The teacher, the supervisor, and the students have all been involved in a microteaching exercise.

Microteaching is designed for teachers who want to improve their teaching skills. The key elements of this training method, illustrated in the above example, include:

(1) *A controlled, constructed setting for producing instructional skills.* By reducing the length of the presentation, the scope of the content, and the number of students, the graduate student in microbiology can practise an instructional skill, such as giving a laboratory demonstration, in a setting free of many of the complexities of the actual classroom.

(2) *Feedback from multiple sources.* After giving the 10-minute microlesson the teaching assistant is provided with suggestions or feedback for improving his performance from a content expert acting as the supervisor, from the students he has taught, and from a videotape playback.

(3) *The opportunity for immediate integration and application of feedback.* After the feedback has been received there is an opportunity to integrate and apply these suggestions in reteaching to a different group of medical students.

Five essential propositions underlie microteaching as a training method:

1. The most effective way to master the skills of teaching is to practise one skill at a time

Too often a teacher may be informed by his department chairman, students, or colleagues that he needs to "liven up his lectures" or "allow students more opportunity to participate". Such advice is rarely helpful, for if the teacher knew how to deliver an exciting lecture or increase student involvement he would probably be doing so.

In microteaching, an individual wishing to improve his instructional effectiveness concentrates on the objective of practising a single instructional skill, mastery of a unique set of curricular materials, or demonstration of one teaching method. Focusing on specific objectives, rather than the teaching-learning process in general, allows a teacher to discriminate among the elements of teaching, and assists him in practising a particular technique and incorporating it in his behaviour. For example, if the objective of a health educator were to increase student participation in the classroom, he might concentrate on using positive verbal reinforcement (such encouraging comments as "Good", "Excellent", or other statements indicating satisfaction with the response); or non-verbal reinforcement (such actions as nodding his head affirmatively, smiling, or moving towards the student).

By concentrating on a particular skill, a teacher can begin to recognize the behavioural components of that technique and the situational factors that dictate their use. For example, the health personnel educator who has learned what kinds of verbal and non-verbal cues constitute reinforcement and how to use them can then employ this skill to bring about maximum participation. When a teacher has mastered a variety of instructional techniques and knows the effect of each, he can apply them to achieve instructional aims in a planned rather than a chance arrangement.

2. The complexities of the actual classroom situation limit its value in the training of teachers

Most teachers learn how to teach on the job, but classroom practice has significant limitations. First, there is simply too little opportunity for trial and error. A beginning teacher, in particular, is often anxious about making a good impression on his students. Consequently, if his first lecture is a success and his first group discussion a failure, the chances are that he will become committed to the lecture method of instruction as the most effective way to teach. Secondly, there is only limited opportunity for a teacher to receive feedback on his performance in the classroom, and even that is rarely sought. Finally, and most important, students are in a classroom to be taught effectively, not to be practised on.

Microteaching is designed to provide a safe setting for the acquisition or refinement of educational skills and techniques. A beginning teacher might find delivering a lengthy lecture to a large body of students an awesome task. Practising this method of instruction in a microteaching setting, where the class size, the time, and the scope of content are reduced, considerably alleviates this anxiety. Rather than deliver a 50-minute presentation to a group of 75 students, he can concentrate on one aspect of the lecture, perhaps the introduction only, and practise this component in a 5-10-minute microlesson to a group of 4-5 students. Having mastered the introduction, he is ready to practise the body of the lecture and the conclusion. Since the students observing the lesson would usually not be the teacher's, he is freer to experiment and less anxious about receiving student feedback.

3. The more knowledge a teacher has of his performance during a practice session, the more valuable the experience

Supervision is generally equated with evaluation and is therefore regarded by many teachers as something to be avoided. This is unfortunate, since constructive supervision can be one of the best resources in a teacher's professional development.

Microteaching greatly increases the opportunity for feedback. Since the emphasis is on practising a specific skill or achieving some other precise objective, the teacher, the supervisor, and the students have a clear picture of the purpose of the microlesson before it is presented. As a result, the critique that follows is concerned not with the overall performance, but with only one aspect of teaching behaviour. This approach is generally less threatening and results in more specific recommendations for improving teaching.

The several sources of feedback are designed to provide a teacher with maximum insight into his performance in the light of his goals. The teacher and the supervisor together review student comments, as well as video or audio playbacks, and analyse the way in which the performance might be further improved. This feedback can then be immediately translated into practice by reteaching the lesson to a different group of students. The emphasis in microteaching is on helping a teacher to improve, *not* on judging his performance.

4. A training method that can be varied is superior to one that is rigid

The most prevalent model for training beginning teachers takes the form of education courses supplemented by practice teaching in which they observe and work with highly competent "master teachers", with the expectation that practice teaching will help the student's transition from the theory to the "real world" of teaching.

This model has grave limitations. Its value for the trainee depends both upon the expertise of the master teacher and his relationship with the trainee. The supervisor simply may not allow much opportunity for the beginning teacher to practise, or may not provide him with adequate supervision. Even in the ideal relationship, however, there are drawbacks. For example, the master teacher cannot interrupt the classroom session to offer constructive suggestions, and there is no opportunity for the trainee to stop his presentation and repeat some portion that needs improvement. Also, practice in the classroom must be integrated into the flow of the subject-matter: the skill or technique being practised must fit well with the content specified for that day.

Microteaching, on the other hand, allows for maximum control of the practice session. The length of the teaching, the number and kinds of students, and the method of feedback can be varied according to the goals of the particular session. For example, the teacher, referred to earlier, who is interested in improving his skills in lecturing, can, after gaining comfort in presenting a 10-minute lecture to 4–5 students, give a 20-minute lecture to 10–12 students, thus more closely approximating his teaching in the actual classroom. Unlike conventional practice teaching, microteaching provides and opportunity to practise the skill of lecturing until it is mastered, using videotape and written comments from the supervisor as a record of progress.

Since a number of variables can be easily manipulated in this constructed setting, microteaching is also an excellent research method. By manipulating a single variable, such as the nature of the supervision, countless hypotheses related to the improvement of teacher effectiveness can be investigated. Videotapes and the written feedback supply the researcher with recorded data from which he can work.

5. A genuine teaching experience is superior to an artificial one

Peer teaching, role playing, and other simulated teaching experiences are being widely applied in teacher-training programmes. Although these methods do offer better opportunities for teachers to practise skills than the classroom, there has been a good deal of questioning about the transfer of learning from these experiences to the actual teaching situation. Fundamental to the microteaching concept is the fact that it is real. Although the setting is constructed, *bona fide* teaching of real students occurs.

INCORPORATING MICROTEACHING INTO THE PROGRAMME OF A SCHOOL FOR THE HEALTH PROFESSIONS

Health personnel educators face the dual task of improving the instructional skills of existing faculties in schools for the health professions and of developing these skills in graduate students about to begin teaching. Perhaps one of the soundest and most economical routes for achieving both ends is to train the two groups simultaneously, using microteaching as the vehicle.

Where to begin

Graduate students in both basic and clinical sciences frequently function as teachers under an experienced faculty member as part of their academic work, but rarely does any formal training in education accompany this experience. This situation provides an excellent opportunity to introduce microteaching as a method for assisting these students to acquire the necessary instructional skills. Short-term programmes could be designed to increase their competence in conducting lectures, demonstrations, or group discussions. Since these programmes would not necessarily have to constitute a formal, academic course, both established faculty and graduate students might be offered this opportunity. The faculty members could be asked to present a live or videotaped lecture or laboratory demonstration to serve as a model for introducing the graduate student to these techniques, to function as supervisors in microteaching sessions, or to serve as consultants in designing the training programmes.

Designing and implementing a microteaching training programme

One of the most important decisions in designing a microteaching programme is identification of the specific techniques or strategies to be practised by the participants. Since training in instructional skills that are not relevant to trainee needs is generally wasted effort, it is prudent to involve potential participants in the planning stage through interviews or questionnaires that can quickly isolate those instructional areas in which they feel some need for assistance.

An expert in education is needed to assist participants in this identification, to provide the educational content of the programme, and to oversee the operational details of the microteaching setting. For a small programme with 15–20 trainees, one educator and 3–4 faculty supervisors familiar with the content of the programme and trained in the microteaching process are sufficient. If videotape recorders are used, an operator must be available to man the equipment. If the supervisor can be spared this task, it permits him more time to concentrate on the teacher's performance. If not, supervisors can be quickly trained to operate the equipment. For a larger training programme, staff should be increased accordingly.

Although several options are available for introducing this training activity to participating teachers, it will be most productive if at least one day before the microteaching programme begins participants read the material that describes the skill to be practised; take part in a discussion that leads to the formulation of those criteria that demonstrate effective use of the skill; view a live or videotaped presentation of the skill to which they can apply the criteria; design the evaluation forms to be used by students and supervisors; plan a microlesson that incorporates the skill to be practised; and become familiar with such operational details as the expected length of their lesson, the time of the reteach, and the kinds of students to be taught.

Since microteaching is real teaching, students must be recruited who approximate, as nearly as possible, to those that the teacher ordinarily encounters. If, for example, one is conducting a microteaching programme to improve the questioning skills of teachers responsible for a basic science programme in a medical school, then beginning medical students would be the most suitable choice.

Although the number in a microteaching session can range from 1 to 10 students, depending upon the purpose of the lesson, 4 or 5 students is usual. In deciding upon the number it is well to keep in mind that microteaching is designed to assist teachers, not students. The setting, therefore, should be one in which teachers feel free to experiment without fear of failure. Unless a large number of students can be justified, the groups should be kept small so that concentration of the skill and maximum feedback can be achieved.

There is no prescribed length for the microlessons; they could vary in length from 3 to 30 minutes, depending upon the goals of the programme, the number of participants, and the time available. The most frequent length is 5–10 minutes, since this period generally affords adequate opportunity to practise a particular skill and to cover a significant amount of content.

Similarly, the length of the critique may vary. Ten minutes is generally adequate to allow feedback from students, supervisors, and videotape. With the format of a 5-minute teaching session and 10-minute critique, two teachers can complete a teach-critique-reteach-critique cycle in an hour. For example:

9.00-9.05	teacher "A" — teach
9.05-9.15	critique
9.15-9.20	teacher "B" — teach
9.20-9.30	critique
9.30-9.35	teacher "A" — reteach
9.35-9.45	critique
9.45-9.50	teacher "B" — reteach
9.50-10.00	critique

Although the length of time between the teach and the reteach can be varied, if the reteach is given immediately after the first critique there is generally not sufficient time for the teacher to incorporate in reteaching the suggestions offered. On the other hand, reteaching a day or two later weakens the effect of the feedback received from the critique. An interval of 15 minutes to an hour between the teach and the reteach enables a teacher to plan a second lesson with the feedback suggestions freshly in mind.

Supervision is of critical importance to successful microteaching and merits the following considerations. First, as the focus of the critique increases, its effectiveness decreases. If more than two suggestions are offered for changing performance, a teacher often becomes confused, defensive, or discouraged. Secondly, supervision should be supportive and lead the trainee towards self-diagnosis. This can best be achieved by allowing time for the subject to comment upon his own performance. The supervisor can assist by asking such questions as: "What did you think of the lesson?"; "Do you feel that you met the goals you set out to accomplish?"; "What will you do differently in your reteach?". If

EVALUATION SHEET: SELF-ANALYSIS LESSON

Teacher ____________________ Date ____________________

Instructions: Complete questions 1 and 2 before your first lesson.

Complete questions 3 and 4 before your reteach lesson.

Complete question 5 after your reteach lesson.

Take this completed form with you to the conference with your supervisor.

1. List the objectives of your lesson. ____________________

2. How do you intend to accomplish these objectives? ____________________

3. How successful was the lesson? Cite positive and negative aspects.

4. What changes do you intend to make for the reteach lesson?

5. How effective were the changes you made from the first lesson?

the teacher identifies his own problems, he is much more likely to seek and reach solutions that will lead to improvement of that performance. Thirdly, if videotape replays are available, the supervisor should use this opportunity to reinforce effective behaviour, as well as to point out deficiences. Whenever appropriate, the tape should be stopped, comments given, and the segment replayed. Deferring comments until the end of the replay minimizes the reinforcement potential of the experience.

Finally, evaluation forms provide another valuable source of feedback. They can be used to record reactions from students, supervisors, peers, and the teacher himself. A sample form that a teacher might use in analysing his own performance is reproduced in the accompanying figure. The question could obviously be reworked into reaction forms appropriate to students and supervisors. The most appropriate evaluation forms, however, are those designed to respond to the specific objectives of the microlesson and the individuals responsible for evaluation.

CONCLUSION

Microteaching should not be viewed as a panacea for all the problems related to the training of teachers. While it may, for example, help a teacher to become more conscious of his behaviour, it cannot transform a dull teacher into an intellectually exciting one. Its great advantage is that several valuable training functions occur simultaneously: it provides a setting that focuses on specific skills, enriches supervision, facilitates continuous training and research, and offers safe but realistic practice in instructional techniques.

Above all, microteaching is a flexible teacher-training method and should not be abandoned if, for example, videotape equipment or experienced supervisors are unavailable. Since these and other variables can be adjusted, a precise definition of the microteaching context can vary according to the objectives desired and resources available.

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THE IMPLEMENTATION OF WHO'S TRAINING PROGRAMME FOR TEACHERS OF THE HEALTH PROFESSIONS

Tamás Fülöp[1]

The background and content of WHO's comprehensive, coordinated long-term programme for teachers of medical and allied health sciences have been described elsewhere.[2] This paper is concerned with the implementation of that programme, the purpose of which is to contribute to the improvement in the delivery of both preventive and curative health care.

A Memorandum of Agreement was signed between WHO and the University of Illinois, Chicago, Ill., USA, on 30 September 1970. It states in its preamble that "it is the desire and intention of the parties to bring about a comprehensive and co-ordinated training programme for teachers from schools of medicine and allied health sciences which will enable the participating WHO Regions to set up regional and local (intercountry and country) Health Personnel Teacher Training Centres and thereby contributing to improve not only the teaching standards of schools of health personnel, but also to meet the quantitative needs, i.e., manpower planning in relation to teaching staff". The operational paragraphs state, *inter alia*, that:

(1) The University shall provide in each of the academic years 1970/71 through 1973/74 within and by its Center for Educational Development various training programmes and courses for selected candidates from each of WHO's participating Regions,

(2) ... the training programmes and courses shall include the following:

(*a*) A programme of one-year duration for two to four fellows each academic year which may lead to a degree in Medical (Health Personnel) Education;

(*b*) One course (seminar/workshop) of four weeks duration each academic year for 12 to 14 participants per course from WHO's participating Regions;

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[1] Director, Division of Health Manpower Development, World Health Organization, Geneva, Switzerland.

[2] Fülöp, T. (1973) *Training teachers of health personnel*. In: *Development of educational programmes for the health professions*, Geneva, World Health Organization (*Public Health Papers*, No. 52), p. 84.

(c) One two to four week workshop on-site in the Regions each academic year for a maximum of 25 participants.

The one-year course is designed to train the future full-time members of Regional Teacher Training Centres (RTTCs), among them the directors and deputy-directors. The 4-week seminar/workshops are intended for those who will become part-time teachers for the RTTCs. Finally, the 2-week on-site workshops are designed to "prepare the ground" for the RTTCs by discussing relevant problems with the teaching staff of the institution where the RTTCs will be located.

The goals and objectives for these three types of training have been properly defined (see Annex). The training activities within the framework of this Agreement started in June 1971, when the Center for Educational Development (CED), University of Illinois College of Medicine, Chicago, started to function as an Interregional Teacher Training Centre for Schools of Health Personnel (IRTTC).

In 1971 the WHO Regional Offices for Africa, the Eastern Mediterranean, South-East Asia, and the Western Pacific proceeded to select sites for RTTCs. First the Eastern Mediterranean, then the Western Pacific, and finally the South-East Asia regional offices called upon consultants to assist in the selection of a site and in drawing up a plan of operations. The site of the RTTC for the African Region was selected by the regional office staff.

Consultant visits were arranged in Shiraz (Iran), Sydney (Australia), Bangkok (Thailand), and Peradeniya (Sri Lanka). For the purpose of these feasibility studies, criteria were elaborated and adopted by the consultant groups to standardize procedures for site selection. These criteria were intended to be used as a guide in the data collection and subsequent evaluation during consultants' visits. The consultants also drew up recommendations for the case where the site of an RTTC is selected by the regional office concerned.

In 1971–1973 the regional offices proceeded with the implementation of the programmes as follows:

The WHO Regional Office for Africa assisted in the establishment of an English-language RTTC at Makerere University, Kampala (Uganda) and of a French-language RTTC at the University Centre of Health Sciences, Yaoundé (Cameroon).

The WHO Regional Office for the Americas assisted in the establishment of a Latin American Centre for Educational Technology in Health Sciences in Mexico City (Mexico) and another in Rio de Janeiro (Brazil), which perform the functions of an RTTC.

The WHO Regional Office for the Eastern Mediterranean assisted in the establisment of an RTTC at the Pahlavi University Medical School, Shiraz (Iran).

The Regional Office for Europe, considering teacher training to be a high-priority matter, planned activities such as educational meetings.

The WHO Regional Office for South-East Asia assisted in the establisment of regional centres at the Faculty of Medicine, Chulalongkorn University, Bangkok (Thailand) and at the Faculty of Medicine, University of Sri Lanka, Peradeniya (Sri Lanka).

The WHO Regional Office for the Western Pacific assisted in the establishment of an RTTC at the University of New South Wales Medical Faculty, Sydney (Australia).

The establishment of National Teachers Training Centres (NTTCs) is now being considered in all the regions.

The following training activities have been conducted by the IRTTC within the scope of the above-mentioned agreement, with a view to preparing future leaders and collaborators of RTCCs, where leaders and teachers for NTTCs will later be prepared: three 1-year courses in 1971/72, 1972/73, and 1973/74, with a total of 15 participants; two 4-week seminar/workshops in 1972 and one in 1973, with a total of 49 participants; and a number of 2-week on-site workshops, including those in Sydney, Shiraz, and Bangkok (on-site workshops were also organized in many other places without the assistance of the IRTTC).

An Interregional Seminar on Teacher Training for Schools of Medicine and Allied Health Sciences was held at the IRTTC in 1971, with 12 participants, including top-level administrators of schools for health personnel where RTTCs or NTTCs may be established. The purpose of this seminar was to give participants a greater insight into the nature of educational leadership and the requirements for facilitating the implementation both of basic educational programmes for the health professions and of programmes designed to train teachers for the health professions. A similar seminar in the French language was held in Yaoundé (Cameroon) in 1972.

The network of RTTCs in those WHO regions wishing to establish them was completed by the end of 1973. The first NTTCs started their activities in 1974, and all Member States wishing to establish such centres may have at least one by the end of this decade. Centres for educational research and development at the level of individual schools have already started to develop in several countries.[1] A more rapid development may be expected in the second half of this decade after the NTTCs have started working. The activity of those centres in the

[1] See *Educational research and development centres for the health professions* (unpublished document WHO/EDUC/74.172).

schools in the field of training, research, and service is, of course, not an end in itself. Their main purpose is to assist the schools in training health workers who will meet the real health needs and demands of the community they will later serve.

Now, a further development is being considered—teacher training centres to serve as nuclei for the establishment of so-called health manpower development centres (HMDCs).[1] These would be structures within the framework of which the three main elements of the health manpower delivery process—the planning, "production", and surveillance of health personnel—would be integrated. These three main elements are mostly being developed separately in a somewhat isolated way, and their development has reached different stages in different countries. The planning of health manpower, i.e., defining the quality and quantity of manpower needed for the efficient coverage by health services of the entire population, is being developed in many countries, but in most cases it has no or hardly any influence on the second element, the "production" of manpower. This means that health manpower production is all too often isolated from the planning process and thus from the health services for which it is supposed to cater, with the result that the manpower that is trained is not always appropriate to the country's needs. The third element, the monitoring of health manpower, i.e., the control of whether or not the trained health personnel are able and ready to cope with the tasks for which they were trained and to feed the data back into the planning and production phases so that any necessary corrections may be made (to close the cybernetic cycle of the manpower process), is hard to find anywhere.

The mission of the planned HMDCs would be to promote the balanced development of these elements, to ensure that the health manpower process fulfils its main task, namely the provision and maintenance of manpower for the total health coverage of the entire population by health personnel who are motivated and able to serve their community.

[1] Such centres do not exist anywhere yet, as they are only now (1974) being planned.

GOALS AND OBJECTIVES FOR EDUCATIONAL ACTIVITIES TO BE CARRIED OUT BY THE CENTER FOR EDUCATIONAL DEVELOPMENT, UNIVERSITY OF ILLINOIS COLLEGE OF MEDICINE, CHICAGO, ILLINOIS, WITHIN THE FRAMEWORK OF THE WHO TEACHER TRAINING PROGRAMME

ONE-YEAR FELLOWSHIP PROGRAMME

A fellowship year at the Center for Educational Development provides a setting for an individual to define his role as an educational leader in the health professions. Some may elect to move towards this goal by enrolling in the Graduate Programme leading to a Master's degree in education, others by engaging in more focused work on a specific project. Whether through formal courses, independent study, or project work, each Fellow will be provided with the opportunity to develop skills in such areas as educational planning, educational programme implementation, and educational research and evaluation.

Educational planning

Fellows will be afforded opportunities to engage in several kinds of educational planning during the course of a year, including short units of instruction (e.g., 1–3 hours), short-term training programmes (e.g., 1–4 weeks) for health personnel, or instructional programmes in the biomedical discipline from which they come. Participants may expect to acquire such skills essential for effective planning as:

- deriving objectives from multiple sources
- defining programme goals
- formulating objectives in terms of expected student outcomes
- using generally accepted principles of adult learning to develop strategies for implementing planned programmes
- specifying concrete, manageable evaluation strategies
- articulating alternative techniques to achieving specified objectives, emphasizing the advantages and disadvantages of each
- facilitating the active involvement of educational specialists when appropriate
- identifying and utilizing varied kinds of educational resources
- identifying potential sources of funding and procedures for acquiring them.

Programme implementation

In addition to increasing their competence in programme planning, participants will also be afforded multiple opportunities to acquire some

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of the skills necessary for effective programme implementation. During the year they can expect to increase their competence in some or all of the following areas:

— translating learning objectives into realistic instructional sequences
— stimulating faculty and student enthusiasm and capturing commitment to a programme plan
— facilitating the constructive resolution of interpersonal conflicts that interfere with the effective implementation of planned programmes
— recognizing the advantages and disadvantages, as well as skilful use, of such methods as the lecture or small-group discussion
— recognizing the strengths and limitations of such instructional media as films, audiotapes, television, and skilful incorporation of educational technology into instructional efforts
— facilitating the professional growth of colleagues as teachers
— assessment of personal as well as programme strengths and weaknesses
— systematic experimentation with both organizational and personal implementation strategies.

Research and evaluation

The focus of the fellowship programme will be upon the acquisition of those research and evaluation skills that can aid in the conduct of action research rather than in basic investigations. While it is unrealistic to expect that participants will become sophisticated investigators, the skills they acquire should make it possible for them to assess the major elements of student achievement and programme effectiveness. This capability should be manifested as increased proficiency in some of the following areas:

— utilizing formative and summative evaluation procedures
— selecting evaluation techniques that will measure at different levels:
  (*a*) cognitive processes
  (*b*) attitudes, interests, motivations
  (*c*) skills
— constructing performance tests appropriate to such objectives
— using and interpreting standardized evaluation instruments
— interpreting evaluation data
— formulating a research problem
— utilizing work reported in the literature to identify areas for further study in medical education
— using basic statistical techniques (e.g., probability, parametric and non-parametric statistics)
— writing reports for publication.

FOUR-WEEK SEMINAR/WORKSHOP TEACHER TRAINING PROGRAMMES

The general purpose of the 4-week workshop is to provide participants with an opportunity to refine educational leadership skills that can be applied to the educational problems encountered in the home setting.

The intention is not that they will leave merely with an increased store of information about the educational process but rather that they will be better prepared to use both old and newly acquired knowledge in a manner that will:

— stimulate local improvements in educational practices
— provide a personal example of the application of educational principles to teaching activities
— allow them to teach colleagues some of what they have learned.

More specifically, attention will be directed towards five broad areas that represent the core of effective educational planning and implementation:

(1) The nature of learning
  — principles of adult learning
  — application to curriculum and instructional planning
  — experimental set

(2) Curriculum development
  — the nature, source, and specification of educational objectives
  — influence of social forces upon programme planning
  — rationale for specific planning system
  — design of programme

(3) The nature of teaching
  — selection of instructional methods
  — development of greater skill in selected techniques (e.g., lecture, group discussion)
  — sensitivity to individual and group needs

(4) Instructional media
  — strengths and weaknesses of basic communication devices (e.g., slides, films, television, audiotapes)
  — selection of media
  — skill in preparation of simple media (e.g., 2 mm × 2 mm slides, audiotapes, transparencies)
  — more skilful use of selected media

(5) Evaluation
  — principles of student, teacher, or programme evaluation
  — strengths and weaknesses of specific testing methods (e.g., oral, essay, multiple-choice, practical examination)
  — assessment of problem-solving, clinical performance, attitudes
  — test scoring and reporting
  — use of tests as teaching tools.

The programme is organized so as to allow each participant an opportunity to pursue in greater detail a special interest in one of these areas and will require all participants to develop at least one instructional unit that he can take back to his home setting and share with colleagues.

The 4 weeks will include:
— 3 sessions dealing with learning
— 10 sessions dealing with curriculum (of which 2 will specifically relate to objectives)
— 18 sessions dealing with teaching (including 5 half-days specifically devoted to microteaching, during which each participant will have an opportunity to teach his special instructional unit to others)
— 10 sessions dealing with instructional media
— 10 sessions dealing with evaluation principles and techniques.

In addition, time will be set aside for individual reading, personal consultation with staff members, and participation in colloquia at which distinguished visitors will serve as discussion leaders.

WHO ON-SITE WORKSHOPS

General goal

At the conclusion of a 2-week on-site programme each participant should be able to demonstrate that he comprehends the elementary components of a sound educational process, that he can plan the application of such general principles to solve specific educational problems in his own setting, that he can use at least one instructional or evaluation technique with greater skill than prior to the workshop, and that he appreciates the importance of systematic educational studies.

Specific objectives

Achievement of the general goals will be approached through the following activities in three broad areas:

(1) Educational programme planning
- — identify major sources of programme objectives, from within an institution and from outside
- — plan a rational system for the review and selection of institutional and departmental goals
- — identify conflicts in determining goals and priorities and suggest mechanisms for their resolution
- — recognize ways in which one's own actions may facilitate or impede the planning process
- — recognize the implications for teacher performance of a faculty commitment to independent student study.

(2) Instructional strategies
- — identify the major elements of adult learning
- — recognize teaching practices that facilitate and impede learning
- — distinguish among cognitive, psychomotor, and affective learning objectives
- — write behavioural objectives in each of these domains