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ABSTRACT

This presentation, by an invited speaker at the 46th annual meeting of the National Association for Research in Science Teaching, describes simulation techniques used in the medical education program at the University of Illinois. Medical students interact with simulated patients and acquire problem-solving competencies for use in working with patients. Simulation techniques described include a paper and pencil format using latent image or opaque overlay techniques (with feedback systems, a computer format employing unconstrained natural language, a computer-managed robot (SIM I), and live simulations using role playing. The question of validity of performance on a simulation is considered from the perspectives of content or face validity, or construct validity, and of concurrent validity. Evidence from data suggests that, when simulation techniques are properly exploited, these exercises hold considerable promise of being a powerful tool not only for instruction but also for research into the nature of problem solving. (PEB)

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SCIENCE PAPER 8
SIMULATION TECHNIQUE IN THE TEACHING
AND TESTING OF PROBLEM-SOLVING SKILLS

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SIMULATION TECHNIQUE IN THE TEACHING AND TESTING

OF

PROBLEM-SOLVING SKILLS*

Christine McGuire, M.A.**

Problem-solving is an integral part of living, requisite in every field of endeavor, at every age and for every condition of man. In these days of protest about cultural and sexual biases in education it is important to note that the demand to solve problems is no respecter of persons; its imperatives are the same irrespective of the age, race, sex, class, creed or color of the problem-solver. Among those who face a given problem only the resources -- not the task -- will differ. All must bring to bear the same range of skills in the sequential process that begins with the initial definition of the problem and ends only with its resolution or with catastrophe.

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*Presented at the 46th Annual Meeting of the National Association for Research in Science Teaching, Detroit, Michigan, March 27, 1973.

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The skills that must be brought into play in this task include data gathering and processing skills, data interpreting skills, skill in using a variety of types of resources including expert advice, skill in ordering priorities of data seeking and decision, decision-making skills, skills in manipulating the situation to alter it, skills in monitoring the effects of these manipulations and readjusting decisions or actions to respond to the modified situation.

By imitating a sequential decision process which entails a combination of such skills, simulation offers an exciting technology for both the teaching and the testing of problem-solving competencies. For this reason some more or less exotic simulation techniques have long enjoyed a deservedly favored status as instructional adjuncts in the education of business executives (business and management games), military personnel (war games and training exercises), professional pilots (the Link Trainer), and even astronauts (space flight simulators).

However, despite the extensive literature on the instructional uses of simulation, this technology has been employed in only very limited areas of professional education and the examples set by the demonstrably effective institutional modalities using it have rarely been followed in public and university education. Furthermore, in most elementary and secondary programs genuine simulation of problem-solving activities (as opposed to role-playing and other less structured games) is infrequently employed as an instructional strategy, and its potentialities for assessment have not even been explored in most areas.

The Essence of Simulation

Perhaps such limited exploitation is in part due to the vision of astronomical costs conjured up by the word "simulator." Yet, reduced to its essence, simulation consists merely in placing an individual in a realistic setting where he is confronted by a problematic situation that requires his active participation in initiating and carrying through a sequence of inquiries, decisions and actions. The situation must be designed so that each of these activities triggers appropriate feedback which can be utilized for subsequent decisions about pending action, decisions which will in turn modify the problem in different ways depending on the unique configuration of reactions and interventions each person makes. In this fashion a simulation can be evolved through many stages until it is terminated when the individual reaches an acceptable resolution or is faced by disruptive alternatives brought about by his own decisions and actions.

Recently this essence has been captured in various simulation modalities that are economically and technologically feasible to use in both the instruction and assessment of three critical components of physician competence: skill in interpreting clinical and laboratory data, judgment in patient management, and skill in dealing effectively with patients and colleagues. Because I believe that analogous components of competence are inherent in all problem-solving I should like to share with you our experiences at the University of Illinois where medical students are learning, by interacting with simulated patients, how to cope with the actual daily problems that they will confront as physicians.

Alternative Simulation Techniques

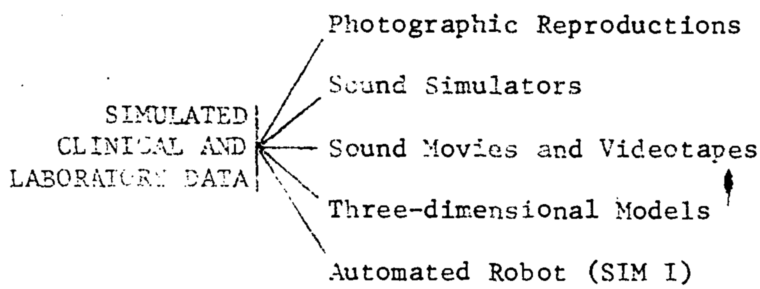
Interpretive Skills

In the teaching and testing of interpretive skills it is clear that provision must be made for the fact that data in any field come to the problem solver through many sensory modalities: visual data, auditory data, tactile data to name but a few. Consequently, in dealing with these important skills in physician education, simulated clinical and laboratory data are presented to the student in realistic form and he is simply asked to interpret them. These simulations may be based on photographic reproductions of x-rays, gross and microscopic specimens, lesions, ECG or EEG tracings and the like--all presented in a form that imitates life as closely as possible. Alternatively, they may employ sound simulators that have been developed for playback of high fidelity recordings of heart, breath and abdominal sounds through individual stethophones so that the sounds come to the student physician's ears in exactly the same manner that they would reach him in real life. Data that involve a combination of sound, color and movement are presented in high quality movies or videotapes depicting the physician-patient interview and/or certain aspects of the physical examination.

More recently several three-dimensional models (for example, heads with eyes, ears and throats) have been developed into which varied pathology can be inserted. With these models the student physician can learn and can demonstrate that he has mastered the skill of using sophisticated instruments both to collect data and to interpret them. Perhaps the most elegant of the three-dimensional models now in existence is that developed by the University of Southern California--SIM I, a computer managed, extraordinarily life-like robot who can be programmed to present combinations of findings that can be modified in an almost infinite number of ways for the edification and evaluation of anesthesiologists.

Figure 1

ASSESSMENT OF INTERPRETIVE SKILLS



Using any or all of these modalities, the student can learn and can be required to demonstrate that he has learned to describe precisely the findings presented in auditory, visual or other forms, to interpret the significance of these findings, to make some initial judgments about their significance and interrelations, to anticipate other findings that might be related to those demonstrated, and to predict what might exacerbate or relieve the situation. The principle is simple: Do not use words to present data that normally present themselves via other sensory modalities. With but a moment's thought the applications to any field are obvious.

Problem-Solving Skills

But interpretive skills constitute only one element in effective problem-solving. Thus in the teaching and testing of physicians it is necessary to incorporate clinical and laboratory data of the type described above into various problem formats that simulate the total situation confronting the physician working up and managing a patient.

Any exercise which purports to simulate this type of decision-making process must have certain characteristics:

> First, it must be initiated in a realistic manner; that is, the problem must be brought to the attention of the student in a form that resembles the form in which it would be posed in the real world; it must <u>not</u> be introduced by a careful predigested summary of the salient features of the situation.
>
> Second, the exercise must require a series of sequential, interdependent decisions representing the various stages in the definition, analysis, and resolution of the problem.
>
> Third, the student must be able to obtain information in realistic form about the results of each inquiry or action, as a basis for subsequent action.
>
> Fourth, once these data are obtained it must be impossible for him to retract a decision that was revealed to be ineffectual or harmful.
>
> Fifth, the problem must be constructed so as to allow for different approaches and for variation in feedback appropriate to these several approaches. Hence, provision must be made for modifications in the problem in response to specific actions taken by each student.
>
> Finally, these modifications must differ among students according to the unique configuration of prior decisions each has made.

Problems meeting these specifications have now been developed in four modalities for use with medical students, residents and clinicians: a paper-and-pencil format using latent image or opaque overlay techniques for feedback systems, in problems which are suitable for either individual or group administration and are amenable to computer scoring and analysis (1,2,3); a computer format employing unconstrained natural language and suitable for individualized administration to untrained subjects (4); a computer-managed robot simulation for individual instruction and assessment; and an oral interaction format suitable for role-playing exercises in individual or small group settings (5,6,7).

In the written format--widely known as Patient Management Problems (PMP)--the clinical situation is introduced with a brief statement of a complaint such as a physician might elicit from the patient himself, from a friend or relative who accompanied him or from a colleague who referred him. Information about the patient's condition is couched in realistic terms appropriate to its source. It may consist of only a few lines or a brief film clip in which the patient indicates his reasons for "seeing the doctor."

Figure 2

ASSESSMENT OF PROBLEM-SOLVING SKILLS

SIMULATED CLINICAL PROBLEMS
- Written Simulations (PMP)
- Computer Assisted Simulations (CASE)
- Automated Robot Simulations
- Live Simulations

The statement of the problem is followed by a list of specific interventions or of general strategies; from these the student selects his initial approach, e.g., further history, physical examination, laboratory evaluation or immediate therapy. He records his decision by erasing the opaque overlay or developing the latent image on a specially treated answer sheet to reveal instructions directing him to the section of his choice. In each new section possible interventions that may yield further information about the patient are listed. The student selects as many or as few as seem appropriate in light of the specific circumstances obtaining at that stage of the problem. Once again, as he records each decision, the results of that intervention are revealed in realistic verbal or visual form.

Both the stages in the work-up and the responses to each intervention are designed to simulate an actual clinical situation in the office or hospital setting. For example, an order for a specific test reveals a laboratory report; an order for an x-ray, electroencephalogram, electrocardiogram, audiogram, or the like directs the physician to a photographic reproduction of the x-ray or tracing; a color plate is provided in response to an order for a smear, culture or biopsy; the patient's reaction is reported in response to medication. Unless a consultation is requested, no interpretation of these data is offered and none is explicitly demanded; as in a conventional clinical setting, data are ordinarily provided in response to any request and these data are available for consideration in making subsequent decisions about the management of the patient.

In this manner a problem is carried through many stages, in each of which the student must make further choices based on the specific responses of the patient which were evoked by his own earlier decisions. The complications which he must manage will depend, as they do in the office or clinic, on the unique combination of specific procedures he elected at earlier stages of the problem. If his approach entails harmful interventions at any stage or fails to encompass measures essential to the recovery of the patient, feedback is given regarding the complication that has developed and opportunity is provided to take appropriate measures to rectify the patient's condition. If these remedial measures are inadequate, the problem may be terminated and the student advised that the patient has suffered a relapse and has been sent to another hospital, or has been referred to a consultant, or has died. Alternatively, if the corrective measures are adequate, the student may be directed to a new section of the problem representing the next stage in the work-up and management of that patient. Each simulation is thus composed of many sections which correspond to the various stages in the diagnostic work-up and treatment of the patient described, and at each stage alternate sections may be included to provide for differing approaches that physicians may wish to take.

The essence of this technique is that it tries to imitate in paper and pencil form the kind of decision-making process which the physician must go through in a real life situation. It imitates that process in several important respects: First, the student has considerable latitude in choosing his own approach to any patient problem presented. Second, he receives prompt feedback on the results of any inquiry or intervention he makes and this feedback is available to him for subsequent decisions about the work-up and management of the patient. Finally, as in real life, the complications that he will need to handle will vary depending on his own unique pattern of decisions.

This type of paper and pencil simulation has been found suitable for the development of problems that vary not only with respect to content but with respect to the nature of the situation. For example, it has been utilized for problems ranging from emergency to long-term chronic disease situations; for problems that focus primarily on management and involve special considerations in monitoring the patient's progress and revising therapy accordingly, and for problems that require the utilization of paramedical and community resources as well as for those in which organic disease is the primary consideration.

Recent technical developments enable us to produce the latent image answer sheets for these simulations in small quantities, by means available to any classroom teacher and at a cost comparable to that of ordinary mimeographed materials. With this breakthrough, written simulation can become a reality in any instructional or testing program. We have, in fact, recently been working with several groups who have designed written simulations on problems in every discipline ranging from the authentication of an artifact found on a carefully described dig, through the selection of the best site and technique for catching trout in a particular stream to finding the least risky way to get a specified shipment of contraband smuggled through customs. Surely everyone can find a tempting morsel in that pot pourri.

A rationale analogous to that used in the construction of written simulations has been employed in the development of computer-assisted simulations of the clinical encounter--familiarly known as CASE. Though focusing more on diagnostic than on management skills, the computer simulation as developed at the University of Illinois College of Medicine has the advantage that the student can address the "computer patient" in unconstrained natural language without reference to a list of possible interventions that would either restrict or cue him unnaturally.

In utilizing CASE the student seats himself at a computer terminal where he is given a brief initial description of the patient's presenting complaint. It is then his task to determine what data he needs in the patient work-up. He does so by interrogating the computer directly just as he would question a live patient and the computer responds to his inquiries in natural language. Similarly, he can indicate each aspect of the physical and laboratory examination that he would undertake with this patient. Again, the computer responds in appropriate natural language with a description of the physical finding elicited or with a laboratory report. On completion of his work-up, the student records his working diagnosis and his plan of management. His entire decision-making process can then be retrieved from the computer and objectively scored and analyzed for feedback to him and his instructors.

Third, the automated robot, SIM I, referred to earlier, can be programmed not only to display various combinations of findings, but also to present a number of problems and to respond appropriately to different interventions of the anesthesiologist. Indeed, SIM I will do everything including vomit on the student who gags him when inserting an endotracheal tube. SIM may even "die" if the student manages him inappropriately or responds inadequately to changes in his condition. However, the lovely thing about this patient is that he never gets tired of being examined or treated, and he can be raised from the dead as often as necessary for the education and assessment of anesthesiologists.

Realistic clinical problems can also be posed in the form of live simulations. In these simulations an actor, a housewife, another student or almost anyone can be "programmed" to simulate a patient in an interview setting. In a diagnostic interview for example, it is the student's task to interview the programmed patient and elicit essential data from him; in a management or therapeutic interview it is his task to cope with the total problem the patient may present. Skills in data gathering, in crisis management, triage, and office and patient management have been explored by a variety of such live simulations.

These simulations differ from the usual games and role-playing exercises in that in programming the simulator nothing is left to chance. The authors of the simulation know exactly how he will respond to each gambit of the student, and this is determined by the history and personality of the patient simulated. In a telephone simulation (8), for example, the student may be seated in an office-like setting 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 student is required to respond as he would to a real-life emergency, the adequacy of his response can be reliably judged and discussed with him, and he can be presented with replications of the same type of emergency until his responses indicate that he has mastered that type of problem. Similarly, in an office simulation the student may be confronted with a series of "patients" each of whom presents a very different problem to which he must respond in varied ways and these, too, can be replicated in fresh and interesting ways until he has mastered each.

In short, written simulations, computer simulations, automated robots and live simulations can all be used to present clinical problems in a realistic form that requires the student physician to respond as he would in the office or clinic setting, that permits him to receive life-like feedback from the simulator and that forces him to cope with the patient's responses to a sequence of inquiries and interventions, much as he will need to do in his actual practice.

Interpersonal Skills

Finally, the physician's interpersonal and communication skills can be assessed by simulated interviews and conferences in which an individual--again, not necessarily an actor--is programmed to take the part of a patient, a colleague or other member of the health team. These simulations differ from the live simulations of clinical problems only in their focus: in the former, the emphasis is on solving a complex medical problem; in the latter, the situations are chosen to focus on the physician's communication skills, his sensitivity to patient and colleague needs and his competence in working with these important people.

Figure 3

ASSESSMENT OF INTERPERSONAL SKILLS

SIMULATED INTERVIEWS AND CONFERENCES
- Programmed Patients
- Programmed Colleagues
- Programmed Teams

For example, in what purports to be a straight-forward diagnostic interview, the simulated patient may, if appropriately handled by the student, provide cues that the real problem is a deep-seated personal, familial or emotional one. The student's sensitivity and response to these cues and his skill in handling such a patient, in communicating with him and in gaining his understanding and cooperation in a proposed plan of management are usually enhanced and are readily assayed by use of such simulated interviews.

Analogous simulated interviews with colleagues have been developed to deal with referral and consultation requests and even with those ticklish situations in which colleagues differ sharply about the management of a particular patient. Clearly, in such settings the student's skill and his professional attitudes are soon apparent both to him and to his instructor or examiner.

Finally, the simulated interview may be designed to require the student to communicate with one or more members of the health team. For example, he may be required to give instructions to a simulated nurse or to request assistance for his patient from a simulated dietitian or social worker, or to make a presentation and to respond to the reactions of individuals who have been programmed to take the role of other members of the health team in a simulated staff conference. Once again, the student can be rated on his communication skills, his interpersonal skills and his professional demeanor in that kind of situation.

Advantages and Limitations of Simulation as an Educational Tool

In examining the advantages and limitations of simulations of the type described above, one must ask about their advantages and limitations compared to what and for what purpose. In these discussions I have often been challenged with a sarcastic comment to the effect that if I think simulations of reality are so great for both teaching and testing why not use reality itself (i.e. actual patients). In answer, I must confess that for most purposes I regard simulation as superior not only to conventional methodologies but also to reality. You see simulation _imitates_, it does not _duplicate_, life; this is both its greatest advantage and, in the minds 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.* Secondly, it is important to recognize that simulation is not an appropriate method for teaching or for testing all aspects of performance. For example, simple recall of factual information is more economically and directly measured by conventional techniques of objective testing. At the other extreme, professional habits can be assayed only by careful and repeated observation over a long period of time in diverse settings. Between these two extremes simulation provides the following important advantages.

Perceived Relevance

As compared with more conventional instructional and evaluation strategies, simulation offers the possibility of designing problems so that they correspond more closely to the life situations a student actually faces. Learning materials, diagnostic tests and summative evaluations composed of such problems appear to the student as far more relevant than typical textbooks or conventional multiple-choice exami-

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*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 somewhat different, life situation.

nations. Such perceived relevance is at the very least psychologically beneficial. And, in these days of concern about the cultural biases of our schools and the testing programs they promulgate, perceived relevance may turn out to be our only legal defense.

Predetermination and Preselection of the Task

It is also of prime importance that by utilizing simulation techniques this perceived relevance can be achieved without being dependent on the accidents of nature and the flow of real problems available at the particular place and the specific moment in time when instruction is to be given or an assessment is to be made. It is obvious that simulation makes it possible to predetermine precisely the exact task which students are to be required to perform. Further, it is clear that in contrast with the "noise" always present in reality, simulation makes it possible to focus on the elements of primary concern in a learning or a testing situation and to eliminate irrelevant and confusing complexities that would complicate the learning and contaminate the assessment. In addition, the fact that learning and assessment tasks can be pre-selected means that they can be carefully graduated in difficulty as the student progresses through the educational program. Third, by developing standard parallel simulations it is possible to confront the student over and over again with interesting variations in what is essentially the same task until he has mastered it.

Standardization of the Task

Just as a given student can be repeatedly confronted with the same task, simulation enables an examining body to standardize the task for all examinees and, in the case of medical examinations, to do so without subjecting one or a few patients to repeated bombardment 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 an attack on nature.

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 instruct the student and to sample his performance with respect to 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, which reality can rarely provide in a reasonable time frame.

Improved Rating of Performance

When the exact tasks that are to compose any learning or examination experience are precisely defined and pre-selected it is possible to develop specific, detailed criteria for judging student performance, and to train teachers and examiners in applying these criteria equitably, consistently and in a manner to provide feedback of maximum benefit to the student. With this type of preparation of teachers and examiners there is no question that a higher degree of interrater reliability can be achieved in the scoring of examinee performance with simulated problems and simulated interviews than with real problems.

In our own studies correlations between repeated scorings of written simulations by different experts range in the neighborhood of .95 - .98. That is as good as you can get in conventional multiple-choice testing where you normally have to rely on such dessicated slices of life that both the student and the teacher are justifiably "turned off."

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 can be allowed full responsibility to careen down their merry way to disaster without any risk whatsoever to anyone! This is important not only in training pilots but in every professional arena, not least of which is the career of life itself. For example, in medicine the student can be allowed to continue along his appalling course and to receive realistic feedback without harm to anyone. Subject to the not so tender mercies of the neophyte, a simulated patient can become progressively sicker, can develop iatrogenic complications, can die, commit suicide, and yet be repeatedly revived, tirelessly to serve the same or other students.

Furthermore, if you wish to provide the student with experience and to test his mastery in the handling of chronic disease it isn't necessary for him, or for you, to wait 50 years watching the gradual deterioration of a real patient. In carefully developed simulations a lifetime of chronic disease can be collapsed into a half-hour problem, at each stage of which the student can be provided with feedback about his interventions in a form which 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 underscored. While the former rarely provides any genuinely relevant feedback, the latter often furnishes it only indirectly, equivocally and long delayed. In contrast, the prompt, specific and unambiguous feedback characteristic of well designed simulations makes them a powerful tool for the enhancement of learning.

It is a genuinely exhilarating experience to walk through the halls after a group of our students have been involved in any of the clinical simulations described above. You find them busily checking with each other on the survival rates of their "patients," admonishing each other on the pros and cons of various approaches to each, and swearing off certain practices for life. It is not at all uncommon to hear such remarks as, "I'll never again prescribe without taking a full drug history; I lost Mrs. Jones in surgery and I deserved to because I hadn't bothered to find out that she was on steroids when she came in." And, of course, we have the usual quota of true stories about the number of students who, after every examination, call the school psychiatrist in a state of severe anxiety because they've "killed a patient." He may be only a paper patient but there's no denying the students are mightily involved with him, and most of us would have to agree that students learn more, more deeply and more joyfully when they are so involved.

Validity of Simulations

This brings us to an exceedingly important question: How valid are the inferences made about performance on a simulation? In answer to this question, we have looked at three types of evidence: evidence about the nature of the intellectual process which the student must go through in order to respond to a simulation (content or face validity); evidence about the extent to which the performance of different groups on these exercises corresponds with reasonable hypotheses about the way in which such groups should differ (construct validity); and evidence about the relation between scores on such exercises and performance on other tests or in other settings (concurrent validity). We hope later to have some evidence about the extent to which performance on simulated problems in patient management accurately predicts some relevant aspect of future performance as a physician (predictive validity), but that is not yet available.

Content or Face Validity

Repeated studies of the intellectual process required in responding to Patient Management Problems and other simulations have been conducted in which experts who review the problems and students, residents or physicians in practice who take them, have been asked both to analyze the exercise and to introspect about the cognitive process required in responding to it. These studies can be summarized as follows: Though no one claims that a simulation duplicates the clinical encounter, there is clear agreement from all studies that the process of responding closely approximates the process of thinking which one must go through in making decisions about the work-up and management of patients who present themselves in the office, clinic or hospital setting. While criticisms have been leveled at specific problems (e.g., that the setting was not adequately specified, or that the physician's role was not adequately identified, or that options which the individual student wished to have included were not always to be found) no general criticism of the PMP format has been turned up in the systematic studies that bear on the issue of content or face validity.

Construct Validity

Studies of the extent to which differences in performance among different groups are compatible with reasonable hypotheses about what these differences should be have yielded exceedingly interesting results: First, scores on the diagnostic portion of Patient Management Problems do not improve overall with more education and experience; in fact, they actually decline with age. Repeatedly, we find that groups with more education and experience request progressively less diagnostic information--even information thought to be essential by a criterion group--before making a therapeutic decision. Fortunately or not, this finding on simulations corresponds with findings from observational studies of similar groups.

On the other hand, increasing amounts of education are associated with somewhat higher scores on the therapy sections of these problems. This relation between education and performance is strongest in those questions which require prompt action in the absence of complete data (as, for example, in accident cases) and in those questions which require radical action (as, for example, amputation). In short, we find over and over that the most experienced physician is most likely to take diagnostic short cuts and is most willing to take decisive action in treatment. And, not surprisingly, at all age levels this pattern of behavior is most characteristic of those physicians who are psychologically most remote from academic settings, i.e., those who are exclusively in individual private practice.

In summary, differences in the responses of various groups to simulations we have studied are in the expected direction and the patterns of responses are closely similar to those reported in observational studies of physician performance in clinical settings.

Concurrent Validity

Studies of the performance of medical students, residents, and board candidates for certification are uniform in revealing rather low correlations between scores on simulations and scores on multiple-choice tests, even those purporting to test ability to interpret data and to solve problems. In our experience the correlations range from approximately .20 to approximately .40 even when both sets of exercises are quite lengthy. This is as it should be if different aspects of competence are sampled by the two types of exercises. Higher correlations would be very suspicious in view of the nature of multiple-choice tests as they are currently employed.

Unfortunately, studies of the relation between performance on the simulations and supervisors' ratings of clinical competence have also yielded very low correlations. This would be most discouraging were it not for two important limitations of the ratings themselves. First, the ratings are not pure ratings of clinical judgment or problem-solving; they are inescapably contaminated by the supervisors' impressions of the man's knowledge, skills and attitudes. Second, the reliability of the ratings themselves is highly questionable; correlations between different supervisors' ratings of the same individuals on the same factors was generally not in excess of .30. This necessarily means that correlations between the supervisors' ratings and test performance are jeopardized by the low reliability of the ratings themselves. To date we have found no solution to this dilemma.

Studies of the relation between performance on simulations and actual clinical performance would seem to provide the best evidence of the concurrent validity of this format, when actual performance can be objectively audited. But this is a very tedious and hazardous business. Our own early studies, admittedly limited, showed sufficient congruence between these two measures to constitute exceedingly strong presumptive evidence of the validity of well constructed simulations as a measure of "real-life" performance. However, more recent data are causing us to re-examine our comfortable assumptions about the nature and generalizability of problem-solving skills. And that brings me to my final and perhaps most important point, the nature of the problem-solving process itself.

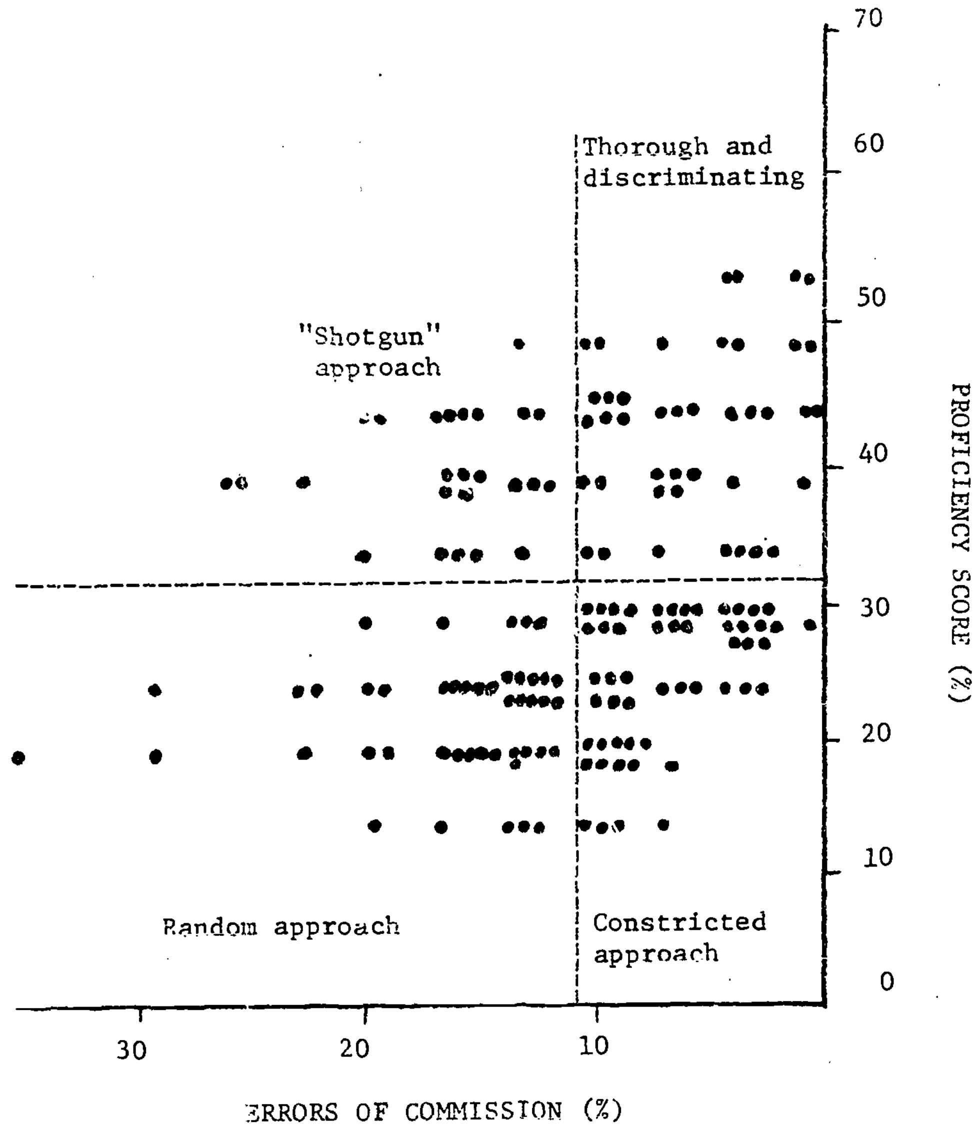
The Nature of Problem-Solving--A Question

In any group, scores on any single simulation ordinarily distribute themselves in the manner shown in Figure 4: Some students will be both thorough and discriminating; others will take a very constricted approach; still others will take a shot-gun approach and some, hopefully few, will do a lot more harm than good.

However, in our experience the correlations between scores on different problems may be very low. In other words, a student's success in dealing with a cardiovascular problem may be only minimally related to his success in dealing with a renal problem; or his success in dealing with a chronic disease problem may not be very closely related to his success in dealing with an emergency problem. You may say: "Of course, what else did you expect? No one does everything well." If that is your response I must assure you that I am not raising the

Figure 4

TYPICAL SCORES ON PMP SIMULATION



hoary issue of transfer of training across chasms. Let me remind you that I am not talking about the genius in theoretical physics who cannot change a clogged carburetor. Rather, I am talking about the student or the physician who, though he can recognize and manage backache attributable to disc disease, cannot recognize and manage backache attributable to claudication of the iliac artery, much less backache attributable to psychogenic factors! Now as a charter member of the Progressive Education Movement of the thirties, that kind of performance offends me.

If I am correct in interpreting the frequent discussions of problem-solving in your professional journals, you, too, seem to design your instructional and testing programs on two assumptions: first, that there are some general problem-solving strategies that are widely appropriate; and, second that experience or mastery in solving one problem is correlated with and probably enhances problem-solving skills on a closely similar problem. If I am correct in believing that these two assumptions do, indeed, underlie your educational programs, then you, too, should be offended by the performance of my physicians.

I have only three possible explanations of the intra-individual variability we are finding from problem to problem: first, the apparent content dependence of problem-solving skills may be only an artifact of variation in the formal structure of the various simulations; alternatively, it may be a consequence of the fragmented, disease oriented instruction characteristic of most medical schools; or finally, and most interesting of all, content dependent performance may not be a mirage, it may be a very real fact of life! I will let you know when I find out, but I warn you now that if it is a fact of life, you'd better know the answer to your problem before you select a physician to solve it. Otherwise my best advice is: Stay well!

Summary Comment

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 exercises give considerable promise of being an extraordinarily powerful tool not only for instruction and assessment of more relevant objectives, but also for research into the very nature of that most complex objective of all--problem-solving and judgment.

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