Comparing the Effects of Problem-Based and Conventional Curricula in an International Sample

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Abstract—In this article, the authors review 15 studies that compare various educational outcomes of problem-based, community-oriented medical curricula with those of conventional programs. The data suggest that problem-based curricula provide a student-centered learning environment and encourage an inquisitive style of learning in their students as opposed to the rote memorization and short-term learning strategies induced by conventional medical education. In addition, community-oriented schools appear to influence the career preferences of their students. The few data available show that significantly larger proportions of graduates from these schools seek careers in primary care. Some of the studies reviewed suggest that students in conventional programs perform somewhat better on traditional measures of academic achievement than do students in problem-based curricula. However, these differences, if any, tend to be very small. Data with respect to performance on instruments measuring clinical competence are inconclusive. Finally, the authors discuss the difficulties involved in carrying out comparative research at the curriculum level.

A number of far-reaching recommendations for improving the quality of medical education in the United States were put forward by the Association of American Medical Colleges' Project Panel on the General Professional Education of the Physician (GPEP) (1). According to the report, medical education, if it is to remain responsive to the needs of society, should adapt to changing demographics, in particular to the dramatic growth in the number of individuals with chronic disease, the increase of the elderly population, and the roles played by environmental factors and life-styles in the determination of health and illness. More emphasis should be put on the physician's responsibility to work with both individual patients and communities to promote health and prevent disease. In addition, basic science teaching and clinical education should be integrated whenever appropriate, and the development of skills, values, and attitudes should be empha-

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sized at least to the same extent as the acquisition of knowledge. Furthermore, the panel suggested that medical schools should offer education that requires students to be active, independent learners and problem-solvers rather than passive recipients of information. According to the report, offering such education will require alterations in instructional procedures.

Indeed, these recommendations, if taken seriously, would require major changes in contemporary medical education not only in U.S. medical schools but also elsewhere. It is not the present authors' intent to discuss the merits and possible shortcomings of the GPEP report. What is suggested here is that it may be useful for medical educators to look at the experiences of schools that already have attempted to carry through some of the recommendations of the report before proceeding with implementation of the recommendations in other programs. Studying the available empirical evidence from these alternative programs might provide an opportunity to avoid mistakes that have been made in the past and to decide the extent to which the report's recommendations are feasible or appropriate.

The purpose of the present paper is to review and comment upon a number of studies that have attempted to compare the results of problem-based programs with those of conventional curricula. This review will concentrate on studies of the educational outcomes of the curricula of an international group of medical schools known as the Network of Community-Oriented Educational Institutions for the Health Sciences (2). This network consists of 30 schools in industrialized and developing countries. The schools include the medical faculties of the University of New Mexico in the United States, the University of Limburg in the Netherlands, McMaster University in Canada, Suez Canal University in Egypt, and the University of Newcastle in Australia. Studies on these schools were selected because their curriculum objectives appear to reflect clearly the spirit and recommendations of the GPEP report.

Students' Characteristics

Data will be reviewed on five outcomes of medical education: students' academic achievement, clinical competence, career preferences, perceptions of their educational environment, and learning styles. These attributes have been selected because they encompass the areas in which differences are to be expected between conventional and problem-based curricula.

ACADEMIC ACHIEVEMENT

One of the implicit assumptions underlying the structure of many curricula is that students have a limited amount of time available to study what is traditionally defined as the core content of medicine. Consequently, if emphasis is put upon topics or activities not considered to be part of this core, the amount of attention that could be spent on core content can be expected to decrease, and this decrease is likely to cause a drop in achievement on core topics. The studies addressed in this section examined whether particular curricular changes were associated with a decrease in academic achievement.

Perhaps the most exhaustive attempts to compare the academic achievement of medical students in a problem-based curriculum with those in conventional curricula have been made by investigators at the medical school of the University of Limburg in the Netherlands in close col-

laboration with investigators from other medical schools in the country (3, 4). All Dutch medical schools have a six-year curriculum and similar admission procedures. Unlike other schools, however, the Limburg medical school uses problem-based, self-directed learning and community-oriented educational objectives.

In order to compare academic achievement in different schools, Verwijnen and his collaborators (3, 4) employed an instrument measuring academic achievement called the progress test. This achievement test consists of about 250 true-false items covering medicine as a whole and selected in a stratified random fashion from a large item bank. Different but psychometrically equivalent versions of this test are administered four times a year to all six groups of Limburg medical students for the purpose of assessment and remediation. This test allows for assessing differences between individual students, between different classes within a school, and even between different curricula. In one investigation (4), the achievement of the six classes of Limburg medical students on this test was compared with that of students in other medical schools in the Netherlands. The Limburg sample contained the whole school population of 565 students. Two other schools together supplied 1,067 volunteers, and a third school allowed the investigators to draw a random sample of 167 of its students. As could be expected, the students' increase in medical knowledge over the years was gradual, although students in one of the conventional curricula showed significantly less progress than those in the other schools in their second year and more progress in their fourth year. Although some statistically significant differences among the four schools showed up at certain points, these differences tended to be small and non-systematic. The achievement scores of the Limburg students were somewhat lower than those of students from two of the other schools at three measuring points, but by the sixth year these differences had disappeared.

Equivalent results were found by Baca and colleagues (5) when comparing the performances of different groups of medical students from the University of New Mexico on National Board of Medical Examiners (NBME) examinations. The University of New Mexico medical faculty runs two separate but parallel tracks: a conventional and a problem-based program. Therefore, comparisons are relatively easy to make. According to Baca and associates, the students in the problem-based track tended to score slightly lower on the NBME Part I examination (which covers basic sciences and is given at the end of the second year) than students in the conventional track. But the students' scores on the NBME Part II examination (which covers the clinical sciences and is given during the fourth year) were similar. However, in a personal communication, Dr. Stewart P. Mennin of the University of New Mexico School of Medicine informed the present authors that in more recent follow-up studies these differences had disappeared.

Saunders and colleagues (6) administered an 80-item multiple-choice test to final-year medical students at the University of Sydney and a comparable group of students at the University of Newcastle, both in Australia. The medical curriculum at the University of Newcastle is problem-based, while that at the University of Sydney it is conventional. The questions were largely confined to internal medicine. Two hundred forty-three University of Sydney students and 45 University of Newcastle students participated in the study (a participation rate of

more than 90 percent for each school). The difference in achievement between the students at the two schools on the test was very small, although statistically significant: Sydney, 71 percent correct; Newcastle, 67 percent correct.

For more than 10 years, Woodward (7) monitored the achievement of McMaster University medical graduates in comparison with those of all the other medical schools in Canada on the Medical Council of Canada qualifying examination. Her data showed that McMaster graduates on the average scored slightly below the national average on the multiple-choice part of the examination, although the results varied from year to year.

The studies reviewed here seem to indicate that, in some cases, students from problem-based programs perform slightly lower on traditional measures of medical knowledge than their peers in conventional curricula but that the differences, if any, are marginal.

CLINICAL COMPETENCE

The ability to care for patients and solve their problems is considered by many educators to be the major objective of medical education. The acquisition of knowledge is, in this view, only useful to the extent that it facilitates medical problem-solving. A major proponent (8) of this perspective puts it this way: "Doctors with encyclopedic information are useless, if not unsafe, if they do not have the problem-solving skills necessary to accurately and efficiently use that information in the care of their patients." If the acquisition of clinical competence is a vital objective of introducing problem-based curricula, the extent to which students from these problem-based curricula master this skill in comparison with students from conventional curricula becomes an important question. Data available on this topic are limited, however, possibly because of disagreement on the issues of what to measure and how to measure clinical competence.

Saunders and associates (6) studied a group of Sydney and Newcastle final-year students. The Newcastle students had studied a problem-based curriculum. The students were presented with two modified essay questions that were intended to measure clinical competence. No differences emerged in the students' performances, although the Newcastle students performed slightly better when items were marked pass-fail rather than assigned numerical scores.

Woodward (7), however, found that McMaster graduates (who studied a problem-based curriculum) consistently scored above the national average on the patient management part of the qualifying examination of the Canadian Medical Council.

Christel A. Woodward and colleagues of McMaster University, in a presentation at the 1981 Conference on Research in Medical Education of the Association of American Medical Colleges, reported the results of a study that used reports from supervisors on the performance of selected 1978 and 1979 graduates of Canadian medical schools in their first postgraduate year. The supervisors were asked to rate the performance of the graduates in terms of the average intern in their program. The present authors' calculation of data from that study showed that 26.1 percent of the McMaster graduates (who studied a problem-based curriculum) were judged as performing much better than the average intern, 38.3 as better, 28.7 as about the same, and 6.9 percent as weaker. The ratings of interns from other Canadian medical schools showed that 10.9 percent performed

much better than the average intern; 34.8 percent, better; 43.5 percent, the same; and 10.9 percent, weaker. However, both comparison groups were quite small.

Finally, Claessen and Boshuizen (9) compared the performances of students from the medical schools of the University of Limburg and the University of Utrecht in the Netherlands on a task related to problem-solving. The students were in their second, third, fourth, or fifth years of medical school. They were tested on two patient cases, each presented on about 50 cards. Each card contained one piece of information about the patient. The students were asked to go through the sets of cards and read each card aloud. Subsequently, they were asked to recall as much of the patient information as possible. The amount and the quality of information recalled is generally seen as a sensitive measure of differences in the structures or organization of knowledge that underlie problem-solving (10). Taken together, the students in the problem-based curriculum were able to recall more information than the students in the conventional curriculum. These data suggest that the former students had cognitive structures available that enabled them to process patient data in a somewhat better fashion than the students in the conventional curriculum. Claessen and Boshuizen attributed this phenomenon to the fact that the students in the problem-based curriculum confront patient problems earlier in their training than do the other students.

In summary, there is weak evidence that students from problem-based programs perform somewhat better on tasks related to clinical competence, but this evidence is limited in scope. The differences are small, perhaps with the exception of the data provided in 1981 by Woodward and colleagues.

CAREER PREFERENCES

The career preferences of medical students tend to be quite stable over the course of their medical-school education. If there is any change between the times of enrollment and graduation, it tends to be a shift from a preference for primary care to one for nonprimary care specialties (11, 12). This state of affairs presents a challenge for the problem-based, community-oriented schools, because their goal is to produce doctors with an awareness of the importance of primary care for the well-being of the population at large. Do they succeed in influencing the preference pattern of medical students? Two studies addressed the impact of the new, problem-based curricula on the career preferences of their students.

The first was carried out at the University of Kuopio and the University of Tampere in Finland, two relatively new medical schools. Isokoski and colleagues (13) investigated the type of medical practice for all physicians registered in Finland between 1978 and 1982. A total of 2,917 physicians were registered during that period. Utilizing the register of the Finnish Medical Association, the investigators obtained data concerning the school of graduation for 93.4 percent of these physicians. Information about the nature of these physicians' practices (primary care, hospital-based service, other) was gathered by means of a questionnaire, which was returned by 78 percent of the physicians surveyed. Subsequently, Isokoski and his colleagues computed for each medical school, and for the five consecutive years studied, a ratio between the observed frequency of choosing a career in primary care and an expected frequency, under the assumption that each medical school graduated the same proportion of physicians pursuing careers in

primary care. Their data show that, on the whole, a significantly larger proportion of graduates from the two new schools chose to practice in primary care centers than did the other graduates. Their report however, did not contain information about regional manpower needs during the study period. Thus, it is impossible to assess the extent to which the career choice pattern resulted from curricular influences or from geographical limitations as to the type of positions available during that period. In addition, it is unclear to what extent the students enrolling in the new and the old schools differed in their career preferences from the start.

Research carried out at the University of New Mexico School of Medicine suggests that the structure and aims of a curriculum may influence the professional preferences of its students (5). This medical school has two curricula, one problem-based and the other conventional. Upon entering medical school, the students of both the problem-based and the conventional track in the study expressed preferences for primary care specialties to the same extent. By graduation, the students in the problem-based track retained their initial interest in family medicine, whereas their peers in the conventional track had to some extent changed their career preferences to internal medicine. According to Baca and colleagues (5), this difference emerged because the students in the problem-based curriculum had substantially more role models in primary care, family medicine, and rural practice.

STUDENTS' PERCEPTIONS

The way students perceive the content of the curriculum and the instructional philosophy underlying it may influence their emotional well-being and motivation to learn. Medical faculties clearly differ in their responsiveness to these needs of students. At the University of New Mexico, for instance, the problem-based track students perceived their learning environment as definitively more flexible and meaningful, as encouraging student interaction, and as having a better emotional climate than did the students in the conventional track (5).

Many medical schools do not appear to be ideal environments for fostering motivated learning. Bender (14) asked a sample of more than 300 medical students from a large Dutch university to state their opinions of the quality of the preclinical instruction they received. The predominant responses were "dull," "tough," "irrelevant," and "hardly adapted to the needs of practice." Schmidt and Moust (15) replicated Bender's study at the University of Limburg, which has a problem-based curriculum. They asked 45 randomly selected students to write a short essay on their experiences in medical school. Subsequently, they extracted all positive and negative evaluative remarks from these essays. Of 147 evaluative comments, 117 evaluations (80 percent) were positive for their problem-based program. Many of these remarks had to do with early exposure to health-care practice as fostered by the school, small-group tutorials, and self-directed learning. Negative judgments pertained to the student assessment system and, to a lesser extent, to small-group tutorials. These data partly corroborate the findings of Woodward and Ferrier (16), who asked graduates to describe the strengths and weaknesses of the McMaster program. They mentioned as strengths (in order of importance) problem-based learning, electives, self-directed learning, independent study, and small-group tutorials. Student assessment

and clinical skills teaching were considered weaknesses.

A comparative study of perceived strengths and weaknesses in the content of various curricula was done by Post and Drop (17). They were interested in learning whether differences could be found in the perceptions of graduates of different medical schools with respect to the amount of emphasis put on various subjects in the medical curricula. In order to investigate this question, they administered a 45-item questionnaire to all medical graduates of the University of Limburg from 1982 through 1984 and to the 1983 graduates of all other medical schools in the Netherlands. The Limburg curriculum was problem-based; the other curricula were conventional. The students were asked to indicate their perceptions of the amount of attention given to particular subjects on a 5-point scale ranging from "too much" to "too little." The response rate was reasonably high for the Limburg graduates but rather low for those from other schools (65 versus 38 percent respectively). The number of forms returned by the graduates from the other schools (498) and the homogeneity of their responses, however, made some conclusions possible. Differences in the students' perceptions of the knowledge and skills gained in their curricula were largest in the areas of primary care, mental health, multidisciplinary cooperation, human behavior, social skills, preparation for postgraduate education, and ethical issues. These topics were rated as having been given less attention in the conventional curricula. Hospital-based medicine and biomedical science were the subjects that received less emphasis in the problem-based curriculum as compared with conventional curricula. It should be noticed, however, that a considerable number of graduates who studied the conventional curricula felt that too much attention had been given to biomedical science and hospital-based medicine.

STUDENTS' LEARNING STYLES

Considerable emphasis recently has been put on research into the ways university students process information. According to Marton and colleagues (18), students appear to develop a preferred "style" of studying. These different styles or approaches to learning show moderate correlations with achievement. Individual students have been observed to favor one of three different broad approaches to the study of subject matter: a "surface," a "deep-level," or a "strategic" approach. The surface approach is largely characterized by rote learning aimed at a literal reproduction of the material and the use of extensive memorization. Students using a deep level approach attempt to integrate what they learn with what they already know, to understand the meaning underlying the material to be learned, and to look for explanations rather than facts. The strategic approach is an attempt to be successful with minimum effort. Under this approach, students do only what is required by a course, and their depth of understanding of the subject matter is largely based on the amount of external pressure provided by the instructor.

In part, these approaches to learning are part of the students' personality traits, but they also may be influenced by the educational context or mode of instruction. A relevant example is provided by Newble and Clarke (19). They administered the Lancaster Approaches-to-Studying Inventory (a 64-item questionnaire designed to measure these three modes of learning) to first-year, third-year, and sixth-year medical students at the University of Adelaide and the University of Newcastle in Australia. The latter has a

problem-based medical curriculum. The results indicated that fairly large differences existed between the learning approaches employed by students from these two institutions and that these differences already existed by the end of the first curriculum year. The Newcastle students rated themselves as having an orientation toward the pursuit of meaning in the material they learned: they more often used a deep-level approach, they had less tendency toward literal reproduction of the subject matter, and they less often had the strategic goal of merely passing an examination than did the Adelaide students.

Several explanations other than the causal influence of the different educational environments involved are possible for these differences. Because a self-rating scale was used, the result may not mirror actual differences in approaches to studying but may instead be attributed to the students' perceptions of social desirability (that is, every student wants to be considered as using a deep-level approach). If this latter interpretation is the case, however, it is difficult to understand why the Adelaide students were less inclined to give socially desirable answers than the Newcastle students.

An alternate explanation would be to ascribe the outcomes to specific characteristics of the populations studied. The groups compared may have been different from the start because of different admission procedures. Indeed, the Newcastle school admits students in part based on previous academic achievement but also takes into account previous nonacademic experiences and personality characteristics. This explanation is unlikely, however, because Coles (20) found the same effect in two quite different populations: first-year students of the University of Southampton and the University of Limburg. In addition, Coles showed that these differences did not much exist when the students entered medical school but that the educational environment provided by the conventional curriculum appeared to induce a surface or memorization approach in its students and discouraged the use of a deep-level approach. One may agree with Newble and Clarke (19), who stated, "The attributes for which we would hope in a university graduate are very much those embodied in the deep approach. Disturbingly, the . . . evidence we have suggests that not only are these attributes unlikely to be achieved by some students but they might be actively inhibited from doing so by our curriculum structures and our teaching and examining methods."

Discussion

The studies reviewed in the present paper illustrate how difficult it is to compare, at the curriculum level, the effects of different educational approaches on the learning and attitudes of students. Two fundamental problems are involved. First, the students whose behavior is to be compared are generally not randomly assigned to their curricula. Therefore, a major requirement for true experimental comparisons cannot be met. At best, comparisons of this kind can be considered quasi-experimental (21). Second, the period over which the curricula are supposed to affect the students is so extended that it becomes difficult, if not impossible, to control for extraneous variables that might affect the outcomes but are not in themselves the subject of investigation. In the studies cited here, these uncontrolled or even uncontrollable variables include (*a*) differences in admission procedures that may make the populations to be investigated different from the start (7, 19); (*b*) differential attrition of students

in the course of the program (4); (*c*) unforeseen and undocumented changes in a program that affect its outcomes; (*d*) the use of volunteers (4, 17); (*e*) difficulty in composing adequate comparison groups that results in the tendency to use whoever is available; (*f*) low response rates (16); and, in particular, (*g*) differential exposure to the instrument used to measure curriculum effects (4, 7). A more detailed assessment of the Saunders study (6) illustrates this last point. In the Saunders study, the students answered multiple-choice and modified essay questions. The students of the problem-based Newcastle curriculum had never encountered multiple-choice questions before in their medical education, while the Sydney students had had no experience with modified essay questions. This differential exposure to the types of instrument used may explain the marginal differences between the schools.

In addition, even if a difference can be trusted to represent a true effect of the curriculum, it is still difficult to point to those curriculum elements that produced the difference. For instance, are students' preferences for primary care careers the result of actual exposure to primary health care delivery, or is the focus on primary care problems in the theoretical part of the curriculum a sufficient condition for encouraging this preference?

A further difficulty is that the problem-based curricula studied were described in the same general terminology. That is, they all were considered community-oriented, used problem-based learning in small-group tutorial sessions as their method of instruction, and emphasized self-directed study. In reality, however, relatively large differences among these programs can be observed. In a survey of 10 of these schools, Richards (22) found that three of them offered their students hardly any exposure to community-experiences, such as making home visits or conducting epidemiological studies in rural areas, and only five utilized problem-based learning as the main instructional approach, although all of them employed it to some extent. Thus, the generalizability of some of the results reviewed here may be doubtful.

It will be clear from these considerations that it is difficult to draw unequivocal conclusions concerning the effects of different curricula. Therefore, the following conclusions can only be tentative.

1. Although the differences in students' knowledge gains favoring the conventional curricula are small or virtually absent, some data appear to imply that students in problem-based curricula do not always attain levels of academic achievement comparable with those of students in conventional curricula. It is important to note, however, that the problem-based curricula have never advanced specific claims with respect to the knowledge to be acquired by their students; their expectation is that their students excel in clinical competence. Since the data available on clinical performance are generally inconclusive, the challenge to schools with problem-based curricula may be to show their students to be superior in clinical competence.

2. The new medical schools with problem-based curricula were founded in response to the changing health needs of their societies. It was felt that the advancement of primary care would help in alleviating at least some health problems of a majority of the world population. The scarce information available on the career preferences and actual career choices of students from these schools supports the notion that an emphasis on primary care may influence the professional perspectives of students; that is, schools with

problem-based curricula seem successful in their attempts to produce physicians with a community orientation.

3. Problem-based programs also seem successful in providing an environment that is congruent with general goals of university education to a larger extent than conventional schools. Apparently, the emphasis in problem-based instruction on independent, self-directed learning fosters in students an inquisitive style of learning, as opposed to the memorization and short-term learning strategies that characterize students in conventional programs.

In conclusion, some recommendations of the GPEP report seem to carry the promise of providing some new and valuable ideas for medical education. However, more and better designed studies are required before definite conclusions can be drawn about the usefulness and the feasibility of many of its proposals. Perhaps the strategy of the U.S. medical schools that offer conventional and problem-based programs in parallel will provide opportunities for experimenting with new ideas about instruction without sacrificing beforehand what is valuable in conventional medical education.

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