WHAT IS THE FUTURE OF PROBLEM-BASED LEARNING IN MEDICAL EDUCATION?

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Student-centered problem-based learning (PBL) has been implemented as an alternative curriculum by several medical schools in the United States and elsewhere. Recently, attempts to integrate PBL with lecture-based curricula have created ''hybrid'' curricula with varying amounts of the philosophical underpinnings of student-centered PBL. Greater clinical and research demands on faculty time threaten to diminish the use of PBL in existing curricula, whereas opportunities for expansion of PBL in medical education are being created by community-based and interdisciplinary education programs.

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Few would argue that it is possible for today's medical student to learn in medical school everything he or she needs to know in the basic medical sciences to optimally practice medicine. Not only has the amount of knowledge in the basic sciences grown but also the importance of some of the smallest details of bioscience is immediately relevant to the diagnosis and treatment of human disease.

Some suggest that medical school curricula should be expanded to five or more years, and some medical schools have begun to require what were once medical school courses, such as biochemistry, as prerequisites to medical school admission. The pressure to increase the number of course hours in an already crowded curriculum has been experienced by many medical school curriculum committees.

On another front, it has become more apparent that even though students may be able to respond appropriately to test questions, many are unable to apply their knowledge to practical medical problems in a clinical context (1). To approach these problems and the age-old experience of students not remembering what they ''learned'' in the basic science years of medical school, faculty have developed medical curricula that attempt to provide early clinical experiences in hopes of engendering relevance to basic science study and have initiated courses on clinical problem solving aimed at teaching students how to solve medical problems.

A study by Regan-Smith et al. (2) may provide some insight into the problem being faced. This study indicates that a large number of students in traditional, lecture-based curricula often memorize without understanding basic concepts in the biomedical sciences relevant to medicine. If this is true, it is small wonder that students are unable to learn, retain, and/or apply the basic sciences to their clinical experiences.

Almost 20 years ago educators at the University of New Mexico borrowed heavily from McMaster University in Canada to experiment with a new approach to the problems associated with the explosion in medical knowledge and the need for students to learn to apply this knowledge to medical problems. They employed student-centered problem-based learning in small groups around common medical problems as the vehicle for learning the basic medical sciences. In

this approach the basic sciences were learned in their medical context. The content of the learning was dictated by the information needed to understand the case, the students' own interests, and the guidance of rather nondirective facilitators whose function was to probe, question, and facilitate group processes that enhance student learning.

The essence of problem-based learning is that the small group of students and a faculty tutor encounter all or a portion of a medical problem, such as a patient presentation with a particular history, signs, and symptoms. The students decide what information they need to ''understand'' the basic science of the case and ''solve'' the problem. They then spend time in individual study pursuing the needed information. After the period of investigative study, the students collectively reencounter the case, applying their new knowledge to understanding the basic sciences surrounding the case and solving the clinical problem. A second period of study may be needed before the students conclude the case. In this way students learn, and learn to apply, the information relevant to the ''problem'' under consideration.

Whereas the original problem-based learning curriculum at the University of New Mexico attempted to expose students to a broad spectrum of clinical cases involving all of the body's systems, little or no effort was made to identify the content of the student learning. Instead, the faculty tutors worked to instill in students a sense of responsibility to learn the basic medical science whenever and to the depth necessary to understand the medical problem at hand, even after completion of the basic science portion of their medical education.

From these beginnings problem-based learning, or PBL, as it came to be known, spread to other medical schools across the United States. Small group PBL also saw an earlier or parallel implementation in Europe. Several schools in the United States such as Bowman Gray University and Rush Medical School chose, as did New Mexico, to initiate a PBL curriculum in parallel with a more traditional lecture-based curriculum.

The results of this curricular approach indicate that students could effectively learn the basic medical sciences using self-directed learning in the PBL format (3). Furthermore, it was shown that these students report being less stressed than did their peers studying in a lecture-based curriculum (4). Finally, a study by Regan-Smith et al. (2) found that PBL students perceive that they understand more of what they learned and ''memorized less without understanding.'' Students in the PBL curriculum at New Mexico showed a slower rate of ''forgetting,'' as measured by repeated National Board Subject Shelf Examination performance, compared with lecture-based students (unpublished data). As a physiologist, I have been pleased to observe that PBL students learned a particularly large amount of physiology, probably because of its clear importance to essentially all medical problems they encountered.

As the idea of PBL has become more and more popular, many medical schools have adopted elements of the approach into their curricula. However, currently, few schools employ pure student-centered PBL. Many curricula incorporate the use of small group-centered case discussions into an otherwise faculty-centered, lecture-based curricula. This is one type of a ''hybrid'' curriculum. The effect often has been to remove from the student the responsibility and motivation for selecting the subject matter to be learned. In many cases even the small group sessions have become faculty centered. However, whereas the ''student centeredness'' of the learning has been lost, the use of clinical cases has been maintained. Consequently, the relevance of the basic sciences has become more apparent and better appreciated by students.

Some faculty members who recognize the value of PBL have tried to implement PBL to enhance learning in just one or two traditional disciplines. These attempts usually are fraught with difficulty and often are frustrating for both students and faculty. The major difficulties arise in that, whereas the concepts of the various classic disciplines can be taught in isolation, most real medical problems involve many disciplines simultaneously. If students are forced to consider only one discipline, say physiology or biochemistry, without considering anatomy and/or pathological mechanisms, they quickly become confused and frustrated. The essence of PBL is interdisciplinary integration and the freedom to explore what is not yet known by the student. It is extremely difficult

to use PBL effectively when these opportunities are not available to the learner.

In some of the current hybrid curricula, PBL has been added on as a weekly or biweekly exercise to add relevance to a group of nonintegrated and noncoordinated lecture courses running in parallel. Whereas students may enjoy the clinical correlation aspects of such curricular approaches, the pedagogical values of PBL are severely compromised.

At the other end of the spectrum, PBL has been made a major part of a well-integrated curriculum combining PBL and a limited number of lectures. A PBL case is used to initiate student learning and problem solving. On completion of a case, lectures are presented that are tailored to address areas of confusion or difficult concepts encountered in the case. This approach provides many of the advantages of student-centered PBL in a more structured curriculum often desired by faculty.

Recent history suggests that PBL is more likely to be incorporated into existing curricula as an add-on or integrated into current curricula rather than being implemented as a stand-alone curriculum. Whereas some student-centered aspects of PBL are lost in these incorporations, careful integration can effectively stimulate student learning and enhance problem-solving skills.

Other factors being constant, one could predict that, whereas some attempts to develop hybrid curricula will fail, the integration of basic medical sciences and clinical medicine will grow. The use of clinical cases as motivators of basic science learning will also grow, as will the rich problem-solving opportunities afforded by case-directed small-group learning. Whereas the spectrum of how clinical problems will be used to enhance learning will be broad, ranging from faculty-centered and -directed case discussions to student-centered PBL, the effect can be to improve the motivation for learning, enhance the retention of basic science learning, and help develop problem-solving skills.

OPPORTUNITIES FOR PBL

Perhaps the greatest opportunity for implementing student-centered PBL is in the clerkships of what are known as the ''clinical years'' of medical school. Whereas some institutions schedule lectures during the clinical clerkships, many curricula focus the educational process on experiential learning venues associated with ward rounds or other faculty and house officer clinical care activities. This environment offers a nearly perfect opportunity for student-directed PBL. Small groups of medical students or students and house officers can focus PBL on cases developed by the faculty that ensure exposure to clinical entities common or important to their discipline. Alternatively, ''real'' patient cases encountered in the hospital or clinics may be the focus of study. These PBL sessions can and should be used to continue the learning or review of the basic sciences as well as patient care principles. It should be remembered that for basic sciences to be a part of the learning, tutors must require students to address basic science issues. For this to happen, the basic science faculty must be involved in the tutorial as tutors or cotutors, or the clinical faculty must be coached to encourage basic science learning.

Although in a PBL tutorial, students are presumed free to select their own learning issues, it is important to realize that the known interests of, and questions by, the tutor have a profound effect on the topics studied. Hence, physiology will be learned if physiologists are involved. One of the primary goals of basic science in medical education should be for students to learn the sciences basic to the practice of medicine and to apply those sciences to the management of patient problems.

A factor impacting medical education is the need to provide more medical personnel to rural and underserved populations. A possible solution to this need is to train physicians and allied health professionals in the underserved areas. Numerous programs have been initiated to provide training in communities at a distance from the ''home'' educational institution. Many of these community-based programs involve the training of allied health professionals including nurses, physical therapists, occupational therapists, or physician's assistants as well as medical students. Interdisciplinary small-group PBL has been used in some instances at these remote sites with great success (5). Whereas care must be taken to ensure that learning in these groups is at an appropriate level for medical

students, PBL coupled with electronic resource access has the potential to provide learning opportunities for students at sites removed from the medical school.

Self-directed learning is the hallmark of the professional physician, and PBL offers the practicing physician the opportunity to pursue continuing medical education (CME) in an effective format. Whereas the focus of CME for physicians is often on patient management, an appropriately directed small-group PBL can serve to help professionals review or learn new basic science concepts as well as patient care. Some CME programs have begun to use PBL as a means of providing continuing education for physicians, and this modality offers a real opportunity for further use.

A third major opportunity for the effective use of PBL is in graduate medical education (GME), in which the learners (house officers, residents, or fellows) not only need to learn and refine their patient care skills but also are motivated to learn and review the basic sciences important to their specialty of medical practice. Because GME ''classes'' in a given specialty tend to be smaller than medical classes, and because the educational processes are less formalized in most institutions, GME offers a hospitable environment for PBL and the effective integration of basic science, problem solving, and clinical medicine.

In institutions at which teaching is the major activity of the medical school faculty, as it is in many developing countries and ''offshore'' medical schools, resources are limited but much more time and effort are committed to education. In these institutions PBL is growing rapidly. As long as there are adequate resources for student learning, including texts and clinical input, PBL provides a very effective means of learning the basic sciences in a medical context even when patients are not physically present.

CURRENT THREATS TO PBL

In 1999, medical education in the United States faces many challenges, including a potential major loss of financial and human resources to support the educational endeavor. The exigencies created by the loss of clinical income and the demand on clinical faculty to spend a greater fraction of their time in patient care efforts are particularly threatening to many schools. Recent years have also seen greater competition for research funding in the basic sciences. Consequently, many basic science educators feel the need to spend more time attending to their research projects so as to be more competitive in obtaining and maintaining research funding. The impact of these pressures on human and financial resources could have major detrimental effects on undergraduate medical education. Whereas PBL may be more effective as a method of medical education with respect to the skills of self-directed learning and perhaps the retention of knowledge, there is little doubt that small group PBL is more labor intensive than traditional lecture-based education. Unfortunately, human labor is the commodity under greatest demand in the current environment.

The current situation in medical schools across the United States makes one question the future of PBL or, for that matter, many other educational activities that are seen as inefficient. For PBL to be optimally effective, significant effort must be invested not only in the development and maintenance of appropriate cases but also in making sure faculty are proficient in the facilitation of the small-group learning. The future of PBL in the next century will depend on both the economics of the activity and the effort extended to make PBL work.

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