
Integration of information-seeking skills and activities into a problem-based curriculum*

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Recent trends in medical education include a shift from the traditional, didactic, lecture-oriented approach to a more student-driven, problem-based approach to learning. This trend provides librarians with an opportunity to develop programs to teach information-gathering skills that support and are integrated into problem-based learning (PBL). In 1992, the University of Pittsburgh School of Medicine implemented the initial phase of a curriculum revision that emphasizes PBL. Since that time, Falk Library of the Health Sciences has provided a large-scale, intensive program integrating information-seeking skills and activities into the first-year Patient-Doctor Relationship course, a sequence that initiates medical school. A multimodal approach to information seeking and sources is emphasized, utilizing print and audiovisual materials, computerized resources, and subject experts. The Falk Library program emphasizes the gathering and use of information as central to both PBL and student skills development. An informal, post-course evaluation was conducted to gauge which information resources were used and valued most by students. This article presents evaluation results, including data on the use of information sources and services, and student perceptions of the librarian's role in the PBL sessions.

MEDICAL EDUCATION IN TRANSITION

Health care reform, technological advances, and achievements in biomedical research and practice have

changed public and professional expectations of health care providers. Physicians are being challenged to acquire sophisticated skills and manage their own lifelong learning in order to respond to the "rapidly expanding knowledge base in the biomedical sciences" [1]. In conjunction with this challenge, medical education has been shifting from a didactic, lecture-centered classroom approach to a more learner-driven, problem-based approach.

A mid-1980s report of the Panel on the General Professional Education of the Physician and College

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Preparation for Medicine (GPEP) called for a reexamination of medical education, contending that medical schools should challenge students to learn independently, offer educational experiences that require students to be active problem solvers, and integrate basic sciences and clinical education to enhance the learning of key scientific concepts [2]. Medical education has been called upon to provide a general professional education that prepares medical students to learn throughout their professional lives rather than simply to master current information and techniques. The GPEP report states that lifelong learning requires active, independent, self-directed learning, and the "ability to identify, formulate and solve problems; to grasp and use basic concepts and principles; and to gather and assess data rigorously and critically" [3].

Problem-based learning (PBL) is an emerging educational method in North American medical schools. It is viewed as an educational process that enables students to meet the goals and challenges of rapidly changing medical practice. PBL is based on the belief that knowledge is remembered and applied more easily if self-directed learning takes place in a setting that allows for immediate application of new concepts. The PBL environment is designed so that specific educational objectives can be met while also providing a forum for students to apply problem-solving skills directly to clinical cases. The approach allows for the immediate practical application of acquired skills and knowledge and enables students to learn about scientific decision making, clinical reasoning, and the humanistic approach to patient interaction [4].

HISTORY OF PBL

During the past twenty years, PBL increasingly has been integrated into undergraduate medical education in North America. By 1974, McMaster University in Canada had developed a method of applying PBL in medical education [5]. In 1979, the University of New Mexico became the first U.S. medical school to adopt a PBL track for some of its students. In 1982, Mercer University became the first U.S. medical school to offer a PBL program for all students in all courses. And in 1985, Harvard Medical School introduced the New Pathways program [6-7].

The past few years have seen an acceleration of the shift to PBL. The 1991 annual report of the American Medical Association Division of Undergraduate Medical Education indicated that 100 medical schools had integrated some form of PBL into the preclinical curriculum [8]. The 1993 report indicated that PBL was a minor part of one or several courses in forty-six schools; a major part of one or several courses in thirty-seven schools; and the major instructional

method in most courses or in a curricular track in twenty-six schools [9].

The medical literature confirms that PBL is becoming a widely used learning methodology in medical education. The medical education literature includes studies on the pros and cons of implementing a PBL curriculum; the viability, feasibility, and costs of program implementation; content coverage; and the changing roles of students, faculty, and administrators [10-15]. Studies have focused on learning styles, cognitive retention, and learning outcomes related to whether students were assigned to or self-selected for problem-based tracks [16-18]. Published studies also have compared exam performance of PBL-track students with that of students educated in traditional, lecture-centered tracks [19-21]. A McMaster University study found that PBL-track students surveyed after graduation rated themselves as better prepared than their professional peers in seven areas: independent learning, problem solving, self-evaluation techniques, data-collecting skills, knowledge of the behavioral sciences, medical record-keeping skills, and understanding of social/emotional patient issues [22].

The small-group, student-driven nature of PBL has been reported as "highly motivating, intellectually stimulating and experientially satisfying" for students [23]. Self-directed learning enables students to become independent, responsible, and confident. Students report making "excellent use" of PBL methods, and most students appear to adapt well to the process of small-group investigation and critical evaluation [24].

Health sciences libraries have been providing bibliographic instruction for many years. Problem-based learning naturally lends itself to library instruction and offers significant new roles and challenges for libraries, including the opportunity for intensive "point of need" instruction. Literature indicates that training in the proper use of information is crucial to successful information seeking and management in PBL [25]. Therefore, students should be prepared to make efficient use of journals, texts, and online resources.

Librarians at Harvard, McMaster, Mercer, New Mexico, and Tufts were active in investigation of the library's role in PBL and in the implementation of curriculum-integrated educational programs. Since 1989, a Medical Library Association special-interest group of PBL librarians has been developing models for and approaches to integrating library instruction and information-gathering skills into PBL tracks in medical education.

Librarians have studied the impact of PBL on bibliographic instruction, professional librarians' responsibilities, student/librarian interaction, end-user searching, and the use of circulating collections [26-29]. A study conducted jointly at several universities

analyzed the effect of PBL on library services and educational programming. The study details challenges to libraries as well as librarians' roles in PBL; challenges include issues related to physical facilities, hours, staffing, budgeting, and collection development [30]. Other studies indicate that librarians involved in PBL activities must provide greater than average on-site commitment to in-depth reference services, circulation functions, and user training in information-seeking skills. The literature also describes unique challenges faced by libraries serving medical schools with concurrent PBL and traditional tracks [31-32].

PBL AND THE UNIVERSITY OF PITTSBURGH CURRICULUM REVISION

Although PBL can be implemented in a variety of ways, the method typically follows several basic principles, largely delineated by Barrow's taxonomy of PBL methodology [33]. PBL incorporates an instructional format characterized by small-group discussion and self-study. Faculty serve as facilitators rather than providers of information in a curriculum that is student centered, not faculty driven [34-35]. In small-group sessions, a real, modified, or fictitious patient case is presented. The problem then is analyzed, and the knowledge needed to understand it is identified and investigated. In PBL, mastering the problem-solving process becomes a goal in itself. Through problem solving, students are introduced to critical reasoning strategies, which enable them to gather facts and develop hypotheses in the investigation of a diagnostic solution [36]. This creates a continuum of knowledge acquisition, synthesis, and application in which the manipulation of data, recognition and analysis of problems, and evaluation of solutions is valued [37].

One goal of PBL is to facilitate the acquisition of basic sciences knowledge and the integration of this information into clinical practice [38]. By emphasizing that seeking the best answer to patient care or treatment-related questions is the key to learning and skills acquisition, this active, self-directed approach lends itself naturally to the everyday work of clinical practice, thus facilitating lifelong learning [39].

Curriculum revisions at the University of Pittsburgh School of Medicine are characterized by a multimodal approach in which PBL is integrated into a curriculum that also includes traditional lectures, large- and small-group workshops, and laboratory exercises. Integrating PBL into the curriculum involves the identification of key courses in which the small-group, problem-solving approach logically applies. An interdisciplinary team of faculty members develops the course objectives and patient cases. Strict quality-control measures guarantee that the resulting

courses will enable students to master skills for patient care and clinical decision making as well as develop an understanding of the basic sciences and scientific concepts upon which clinical knowledge is built.

In the fall of 1992, the School of Medicine implemented the first phase of its curriculum revision, beginning with the Patient-Doctor Relationship Course. This course, the incoming student's initial experience in medical school, is designed as an introduction to fundamental principles of diagnosing, treating, and working with human beings (Figure 1). A major goal is to produce a humanistic physician who interacts compassionately with patients as individuals and considers social and psychological factors in assessment and treatment.

The course begins with a two-week period of PBL in the form of small-group analysis of patient cases. Some of the cases are presented as written case studies, while others are simulated by "live" patient interviews preceding the small-group sessions. Cases relating to five subject areas are presented, each over a two-day period. The five topics studied in 1992 were breast cancer, HIV/AIDS, occupational medicine, geriatrics/long-term care, and pediatric transplantation.

PATIENT-DOCTOR RELATIONSHIP COURSE

Falk Library of the Health Sciences was involved in the conceptualization, planning, and design of the Patient-Doctor Relationship Course, with library faculty members serving on School of Medicine curriculum committees. The involvement of key library personnel in curriculum planning enabled the library to have a clear vision of the committees' goals and allowed for a commitment of significant library resources to the curriculum revision. A primary goal of both the School of Medicine administration and Falk Library was to ensure that students learned to identify, retrieve, manage, and evaluate information as part of the PBL process.

Because students in the Patient-Doctor Relationship Course were placed immediately in a situation where information was required, the library placed high priority on preparing students for the information-seeking-and-use portion of the course. During orientation week, just prior to the course, the Falk Library staff provided students with training in the use of MEDLINE and other resources. Students were given basic bibliographic instruction and an orientation to the library and the Microcomputer and Media Center. The information-seeking segment of the course was explained, with the clear message that library and information skills would be critical to student success in the overall PBL process.

THE LIBRARY PROGRAM

During the two-week Patient-Doctor Relationship Course, each of the five cases was studied over a two-day period. The 144 first-year medical students were divided into sixteen groups of nine students each. Each group was assigned two faculty facilitators, one from a medical specialty and one from the behavioral sciences. One librarian facilitator was assigned to each group. Eight librarians participated in the small groups as facilitators, each dividing their time between two groups. Responsibilities of the librarian facilitators included attending the PBL sessions and guiding the students in the use of information resources. The time commitment during the course was considerable because each librarian facilitator attended twenty-five hours of PBL small-group activity as well as daily faculty briefings and large-group presentations. The librarians were also available for consultation during student independent-study times over the two-week period. Prior to the course, significant library staff time was devoted to preparing materials.

Five of the eight librarian facilitators were designated as information coordinators for the five cases. A faculty member coordinating each case had overall responsibility for planning the specific case presentation. Librarian information coordinators were responsible for compiling relevant resource materials for each case. After researching the cases, the librarians created bibliographies; evaluated print, audiovisual, and computerized resources; and educated the other librarian facilitators about case-specific resources. Librarians identified case-related learning issues that students would likely pursue and located relevant information sources. Working closely with the faculty case coordinators, the librarians finalized lists of appropriate source materials and participated in selecting and enlisting key informants (subject experts).

Although the schedule for each case varied, a typical day began with a general introduction given by the case coordinator (Table 1). "Live" patient interviews presented for the entire first-year class were conducted in four of the five cases. After the introductory session, students then met for approximately ninety minutes in their small groups to discuss the patient cases presented in the interviews. During the small-group sessions, students were given printed copies of patient cases for discussion. The discussion and debate led to the eventual identification of facts about the case, hypotheses, and learning issues, or areas for further investigation. One student in each group acted as a scribe by listing the facts, hypotheses, and learning issues on the blackboard.

After the initial small-group sessions, students had one to three hours of independent study in which they used library and information resources to in-

Figure 1
University of Pittsburgh School of Medicine, first semester weekly calendar

	Patient-Doctor Block	Basic Sciences Block
Aug. 24 - 28	Orientation Week	
Aug. 31 - Sept. 4	Introduction Courses Patient-Doctor Relationship	
Sept. 8 - 11	Behavioral Medicine Sept. 8 - Oct. 22	Immunology Sept. 8 - Oct. 5
Sept. 14 - 18		
Sept. 21 - 25		
Sept. 28 - Oct. 2		
Oct. 5 - 9		Cell Structure, Metabolism & Nutrition Oct. 5 - Nov. 16
Oct. 12 - 16		
Oct. 19 - 23		
Oct. 26 - 30		Clinical Epidemi- ology Oct. 26 - Feb. 15
Nov. 2 - 6		
Nov. 9 - 13	Patient Interview Nov. 2 - Dec. 15	Molecular & Human Genetics Nov. 17 - Dec. 10
Nov. 16 - 20		
Nov. 23 - 27		
Nov. 30 - Dec. 4		
Dec. 7 - 11		

vestigate learning issues. The investigation of learning issues was the primary focus of the library's involvement in the PBL process. Each afternoon, following independent study, the students reconvened in their small groups to discuss what they had learned. The afternoon sessions gave students the opportunity to present facts, apply information to the case studies, arrive at some consensus concerning the learning issues at hand, and wrap up the discussion of each case.

Several of the cases included activities such as small-group patient interviews, traditional lectures, and site visits. For example, during the geriatrics/long-term care case, students went on field trips to nursing homes, day care centers, independent living centers, and long-term nursing facilities.

RESOURCES SUPPORTING PBL

The need for significant resources for the implementation of a PBL curriculum was reflected in the heavy use of Falk Library's sources during the Patient-Doc-

Table 1
A typical day: Patient-Doctor Relationship Course

Breast cancer case, day 1	
8:30 A.M.–9:00 A.M. (entire class)	introduction to the case and opening remarks by case coordinator
9:00 A.M.–9:30 A.M. (entire class)	patient interviews by M.D.
9:30 A.M.–11:30 A.M. (small groups)	small-group discussions of patient case facts and formation of hypotheses; identification of learning issues to be pursued
11:30 A.M.–2:30 P.M. (individual independent study)	independent study; investigation of learning issues utilizing library and information resources
2:30 P.M.–4:00 P.M. (small groups)	small groups reconvene to share information gathered during independent study period; follow-up discussions
4:00 P.M.–5:00 P.M. (entire class)	lecture by expert in field and concluding remarks

tor Relationship Course. The challenge to the library was to make sufficient resources available so that students could investigate learning issues efficiently and successfully. Because all 144 students were looking for information on the same general topic during the same independent-study period, it was necessary to plan carefully the logistics of the information-seeking activities. Librarians had to ensure that the entire library was not disrupted, that other clients could continue their activities, and that PBL students did not become frustrated because books or journals were off the shelf.

Library collections, computers, online systems, audiovisual resources, and study space were used heavily during the independent-study times. Because Falk Library has fairly limited space, it was necessary to identify additional areas outside the library that could be used to house supplemental resources for the first-year students. In preparation for implementing the revised curriculum, the School of Medicine had renovated sixteen small meeting rooms. These rooms and a large conference center, all located in the same building as the library, were reserved by the library to house resources for the first-year students. The distribution of resources in multiple locations minimized library crowding and competition for access.

The packets of informational materials placed in each room were based on the librarians' case-related resource lists. Resource packets included brochures, pamphlets, photocopied journal articles, newspaper clippings, and other print sources. For example, the packet for the breast cancer case contained current and older articles on breast cancer diagnosis and treatment, patient education pamphlets, guides to local and national support services, and articles from the popular literature. Copyright clearance was obtained for all materials placed in the meeting rooms. In addition, resource guides prepared by the librarians provided supplemental bibliographies and case-specific information, including instructions on choosing appropriate Medical Subject Headings, tips on search strategies, and instructions on the use of the university's online catalog.

During independent study sessions, the nine stu-

dents in each of the sixteen small groups were encouraged to divide tasks and use the full variety of resources in the various locations. Sixteen MEDLINE terminals, one per group, were reserved in the library. Also available in the library were reference and reserve materials; the university's online catalog; the book and journal collections; and the Microcomputer and Media Center resources, including computers, software, and multimedia. Traditional reference services and resources were also available. Each of the small meeting rooms was equipped with a videocassette player and monitor for viewing videos, which were available for checkout from a cart stationed outside the rooms.

Key informants were available in the conference center during independent-study time. These individuals were subject experts, researchers, clinicians, lawyers, social workers, patients, corporate representatives, and others. The availability of key informants in a central location during a specific time period avoided problems associated with having new students wandering the labyrinth of the medical center. The informal discussions and question-and-answer sessions with key informants were educational and enlightening for students, as evidenced in their comments and evaluations as well as observations by faculty members and librarians.

Students were enthusiastic about the opportunity to consult key informants and showed initiative in finding experts other than those provided by the case coordinators and librarians. During the occupational medicine case, several students decided they wanted to speak with someone about back injuries. They took the unique approach of going to a construction site at the university and speaking with a construction worker who claimed that his company never had experienced any problems with employee back injuries. The students later discovered that the man they had questioned was the company owner's son. This experience helped the students understand the importance of evaluating the source and reliability of information.

During the independent study periods, the eight librarian facilitators and other library personnel were

available at various locations to guide students to appropriate information resources. This approach, which allowed for extensive one-on-one instruction, was an effective means of introducing students to the skills needed to identify, use, manage, and evaluate information resources. Course faculty and librarians encouraged students to cite sources, evaluate the validity of studies, and critically evaluate journal articles and other materials.

All resources were used heavily during the two-week period. Each student participated in more than twenty-five hours of small-group PBL activity and twenty hours of information seeking and use. Approximately 1,050 learning issues were investigated, and more than thirty key informants were consulted. More than 500 MEDLINE searches were performed; each student executed an average of four MEDLINE searches during the course.

EVALUATION AND RESULTS

A post-course evaluation was developed to gauge which information resources were used and valued most by the students and to determine the utility of investigating various learning issues. Feedback also was sought on how students perceived the librarian's role in the PBL sessions.

On the last day of the two-week period, students were surveyed in their small groups. One hundred thirty-eight (96%) of the surveys were completed. Results indicated that nearly all (98%) of the respondents felt that the initial library instruction and ongoing interaction with librarians provided them with the necessary background to use the library and information resources effectively. The library and information sources were rated extremely useful, with a score of 4.31 on a scale of 1 to 5 (1 = not useful, 5 = very useful).

Table 2 shows how various resources were rated using Likert scale rankings and ratings based on a given list of items. Key informants were ranked as the most useful, with a score of 4.56, followed by the packets of materials placed in the small-group meeting rooms, MEDLINE, and the resource guides. When asked to rate sources in an open-ended question, students again rated key informants as the most useful, followed by other sources, then MEDLINE. Comments indicated that the students appreciated being able to ask key informants direct questions and receive immediate answers. Students were approximately equally divided as to whether the one to three hours of daily independent study was adequate.

Students also were asked to make recommendations for the future. Many suggested that more MEDLINE terminals be made available; although probably few understood that it was a system limitation on simultaneous MEDLINE users that limited available

Table 2
Usefulness of information resources

	Scale of 1 (not useful) to 5 (very useful)	% students rating resource most useful
Key informants	4.56	38
Packets of materials (in small-group rooms)	4.06	9
MEDLINE	3.62	21
Printed guides (in small-group rooms)	3.12	<5
Other (books, journals, etc.)	—	24
Online catalog	—	8

terminals. Students also suggested that additional online resources be made available, that greater numbers of general texts be reserved for their use, that more restrictive time limits be placed on the use of reserve materials, and that books and journals be reshelfed more quickly. Several students suggested that an area be designated where materials could be placed after use, so other students could find those materials more easily. Students also commented that some journals were at the bindery during the two-week period.

Overall, survey feedback and comments indicated that the majority of students responded positively to the PBL experience. Student involvement in each case was extensive, and they approached seriously the task of finding answers in support of the learning issues. Written and verbal feedback concerning the library was particularly positive and indicated that students had been impressed not only with the information resources, but also with the role of the librarians.

CONTINUING CHANGE

In preparation for future iterations of the Patient-Doctor Relationship Course, the library continues to review student suggestions and implement changes to improve the program and minimize potential logistical problems. Modifications include placing a thirty-minute time limit on the use of reserve materials for the course. Bindery shipments are scheduled so that journals always are available on the shelf during the two-week course. Also, additional shelvers are made available to reshelve books and assist students in locating materials.

The role of the librarians continues to expand as they assume increased leadership in course planning. Using the experience gained in the first year, librarians have become more proactive in identifying information sources, contacting key informants, and communicating with faculty case coordinators. Librarians also are participating in the design and implementation of the Integrated Case Studies PBL course for second-year medical students. In this course,

which reinforces the library and information skills learned in the Patient-Doctor Relationship Course, students study fifteen to eighteen cases over a seven-week period. This progressive approach enables students to develop increasing levels of sophistication in information-seeking skills as they advance through their academic program.

CONCLUSION

The participation of Falk Library in the PBL curriculum has proven beneficial for the library, librarians, teaching faculty, and students. Librarians have become partners with teaching faculty in curriculum development and in the educational process. The librarians have developed a dynamic working relationship with the School of Medicine administration and faculty. Students have gained experience and expertise in information skills. Each librarian facilitator has become a resource to eighteen first-year medical students, who continue to consult with that librarian for ongoing information needs. The heightened visibility of the library enhances its future participation in School of Medicine curriculum activities.

Librarians have an opportunity to play a key role in the educational process as more medical schools revise their curricula and place increased emphasis on PBL. Other disciplines such as nursing and dentistry also are adopting PBL in their educational programs [40-42]. Although this expanded role requires a significant commitment of time and resources, the long-term benefits to libraries, students, and faculty are considerable. The increased involvement of librarians in planning and implementing curricula broadens their role as educators. Rather than acting as a supplemental, peripheral resource in the educational process, the library is positioned as an active, full participant in medical education and lifelong learning.

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