JAOA MEDICAL EDUCATION

Lake Erie College of Osteopathic Medicine's Preclinical Problem-Based Learning Pathway Program: An Alternative Medical School Curriculum Design

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In 1999, the American Osteopathic Association approved plans for "substantive change" to the medical curriculum at Lake Erie College of Osteopathic Medicine (LECOM) in Erie, Pa. In addition to the school's traditional, lecture-based curriculum, LECOM sought to create alternative—but distinct—learning pathways: independent study (described elsewhere) and problem-based learning (PBL). After selecting a long-standing, successful PBL program to guide our efforts and after a 1-year period of planning, developing, piloting, and refining the program, we introduced PBL in the 2000-2001 academic year. This learning pathway consists of carefully constructed cases that allow for progressive disclosure across group-tutorial sessions, from patient presentation to diagnosis and management. With more than 5 years of data on student performance and evaluations, LECOM can investigate the merits of its three basic science learning pathways. The description of LECOM's longitudinal database will allow program evaluators to assess and compare each of the three basic science learning pathways.

J Am Osteopath Assoc. 2007;107:443-449

The Lake Erie College of Osteopathic Medicine (LECOM) in Erie, Pa, received full accreditation status from the American Osteopathic Association (AOA) with its first graduating class in 1997. The school's preclinical basic science curriculum at the time of its inception was based on a traditional lecture-discussion learning pathway. In 1999, the AOA Council on Predoctoral Education approved LECOM's request to develop and implement two additional, "alternative" preclinical curricular pathways: independent study[1] and problem-based learning (PBL).

Each pathway concentrates on a specific element of learning. The traditional learning pathway is characterized by large-group lectures and structured laboratory experiences interspersed with teacher-directed class assignments. Conversely, the independent study pathway is minimally structured and allows students to learn at a self-determined pace.[1] Problem-based learning consists of clinical cases reviewed by students in small groups. These small groups are facilitated by at least one faculty member and identify group-derived learning issues (eg, areas that highlight a knowledge deficit).[2-4] Key features of each learning pathway are presented in *Figure 1*. All three pathways are distinct but equal in overall learning outcomes.

Like independent study and traditional learning pathways, PBL is a unique alternative curricular pathway offered in a stand-alone fashion. In PBL at LECOM, elements of the sci-

- ■ **Traditional Lecture-Discussion**
- □ Traditional boundaries between first-year and sophomore students
- □ Students participate in large groups
- □ Basic sciences presented in organized lectures, which allow for complementary audio-visuals
- □ Students regularly tested on established amounts of material
- □ Faculty available for regular contact with students
- ■ **Independent Study**
- □ Traditional boundaries between first-year and sophomore students
- □ No group structure; students proceed at self-determined pace within defined limits
- □ Basic sciences learned through highly structured objectives and self-study using various resources
- □ Students tested on each module when they consider themselves prepared; if deficiencies exist, must remediate before continuing to next module
- □ Faculty available as resources to students
- ■ **Problem-Based Learning**
- □ No boundaries between the first-year and sophomore students
- □ Students participate in small groups
- □ Basic sciences learned within clinical context; shifts between organ systems and disease categories
- – Each content area covered twice, once in first year and once in second year
- □ Students regularly tested on established amounts of material
- □ Faculty available as facilitators of student groups

Figure 1. *Key features of the three learning pathways available at Lake Erie College of Osteopathic Medicine in Erie, Pa. Pathways are available in the first and second years of osteopathic medical education.*

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Submitted July 28, 2004; revision received March 3, 2006; accepted March 13, 2006.

ence content in the first year (*Figure 2*) are revisited in the second year (*Figure 3*). Format and delivery of other courses (eg, osteopathic principles and practice, clinical examination) vary and are not specific to independent study or PBL because all students, regardless of learning pathway, participate in these courses together.

The current study summarizes the means used to introduce PBL at LECOM, describes key elements of implementing PBL, and presents a scheme to evaluate PBL outcomes compared with those achieved through the traditional and independent-study[1] learning pathways. In providing all aspects of LECOM's PBL program implementation, the current study responds to criticisms of Sheets and Anderson[5] that only 12% of articles describing curricular development include all of the steps taken to develop the curriculum, and only 29% of such articles describe all essential components of the curriculum.

Program Development

When institutionalizing a new educational program, there are three distinct choices: *de novo* development, which typically requires significant financial and personnel resources; *carte blanche* adoption, though seldom is there a perfect match from one institution to another; and selective adaptation, a compromise between these two models. The selective adaptation approach was chosen for LECOM so that the PBL pathway would be operational within 1 year. After examining a number of existing programs, we chose to base our model on the problem-based learning program at The Ohio State University in Columbus. *Figure 4* summarizes LECOM's adaptation process, including AOA approval for "substantive change,"[6] and provides an overview of the steps taken and their approximate times for completion.

Program Implementation

Problem-based learning in medical education supports four primary goals:

- fostering clinical thought processes (eg, problem-solving skills)
- enhancing acquisition, retention, and use of knowledge
- encouraging self-directed learning
- motivating students to learn concepts instead of merely memorizing facts[7,8]

Similarly, passive learning of information in PBL is almost completely eliminated.

At LECOM, PBL enrollment is limited to 40 students per year. Groups consist of eight students and one faculty facilitator (basic science instructors work with first-year student groups, and clinical science instructors oversee sophomore groups). Facilitators' primary group-related responsibilities are to distribute course-related materials and nurture discussion. A series of clinical cases (presented in modules, one case per module) serves as a basis for learning the basic sciences during these 2 preclinical years. Approximately 31 cases are presented each year to first-year student groups and between 37 to 39 cases are presented to sophmore groups. Although first-year student groups originally met 3 times per week and sophomore groups met twice weekly, both groups currently meet 3 times per week for 2 hours per session.

- **Semester 1**
- Gross anatomy
- Reproductive: embryology and birth defects
- Inherited metabolic disorders
- Cardiovascular: heart and cardiac ischemia
- Respiratory: pulmonary mechanics, gas exchange, and transport
- Electrolyte balance and excitable tissue
- Endocrine: posterior pituitary
- Blood: hemostasis and clotting dysfunction
- Musculoskeletal: muscle structure and function
- **Semester 2**
- Renal: glomerular and tubular function and micturition
- Endocrine: anterior and posterior pituitary
- Central nervous: spinal cord and cerebral cortex
- Cardiovascular: cardiac cycle and output, heart function, blood pressure control, and blood
- Blood: red blood cell diseases
- Skin and burns
- Gastrointestinal: esophagus and intestines, motility, and secretion
- Central nervous: basal ganglia and cerebellum
- Endocrine: control of metabolism and diabetes mellitus
- Nervous: peripheral nervous system and neuromuscular junction
- Endocrine: thyroid and parathyroid
- Reproductive: normal male and female reproductive functions
- Musculoskeletal: joint diseases

Figure 2. *Problem-based learning pathway curriculum for first-year students. When the content areas listed are studied in conjunction with a problem-based learning case, the learning issues selected by the group should include all relevant basic sciences associated with that topic. Basic sciences include anatomy, biochemistry, embryology, histology, immunology, microbiology, molecular biology and genetics, neuroanatomy, pathology and pathophysiology, pharmacology, and physiology and cell biology.*

With each clinical case, the objective is not to diagnose but rather to identify learning issues, which provide students with a basis for independent study before the group meets again. *Learning issues* are topics that students do not understand while discussing a case during a group session. The students recognize that they need to better understand these topics (ie, increase their knowledge in the basic sciences) to proceed logically through cases. For example, a student might identify "the cardiac cycle" as a learning issue so that they could fit "heart sounds" into a meaningful context when they are mentioned in a case. In each successive session, students share new information, discuss the case, and identify additional

- **Semester 1**
- Gastrointestinal: stomach, liver, and pancreas
- Blood: white blood cell diseases
- Microbiology: viruses
- Gerontology
- Cardiovascular: regulation and heart failure
- Microbiology: parasitology
- Renal: water and electrolyte balance
- Endocrine: adrenal gland
- Reproductive: pregnancy
- Nervous: cranial nerves, cerebral blood flow, and degenerative diseases
- **Semester 2**
- Central nervous: special senses
- Microbiology: bacteriology
- Central nervous: infections of the nervous system
- Musculoskeletal: autoimmune diseases
- Psychiatry
- Gastrointestinal: pathology of gastrointestinal tract and liver
- Blood: myeloproliferative diseases
- Immunology: immune response, antigens, and antibodies
- Cardiovascular: diseases of the heart
- Pulmonary: infections
- Toxicology
- Cancer and chemotherapy
- Immunology: immunopathology
- Emergency medicine and trauma

Figure 3. *Problem-based learning pathway curriculum for sophomore students. When each of the content areas listed are studied in conjunction with a problem-based learning case, the learning issues selected by the group should include all relevant basic sciences associated with that topic. Basic sciences include anatomy, biochemistry, embryology, histology, immunology, microbiology, molecular biology and genetics, neuroanatomy, pathology and pathophysiology, pharmacology, and physiology and cell biology.*

learning issues based on continued progressive disclosure of the case by the facilitator as well as the group's related discussions. Each case is discussed in at least two sessions, but some cases may require additional sessions depending on students' familiarity with the topics at hand.

Students' knowledge, originally tested every 5 weeks, is currently tested every 6 to 7 weeks using board-style examinations, comprising multiple-choice and matching questions. Faculty members submit test questions to a test-writing committee. Although questions are different each year, many questions are identical among groups in any one examination, which allows for intergroup comparisons. Some questions may be different if unique learning issues were identified by different groups.

At the end of each semester, each group of students and its facilitator evaluate each other regarding group process. At the beginning of the next semester, the groups are reconstituted with different membership and a balance of student gender and past performance.

Cases

Each PBL case is based on physicians' real experiences with patients and comprises health-related problems and clinical information from the time the patient first visits a physician continuing through associated diagnostic and disease-management processes. Cases are organized in a modular format based on discrete "blocks" of information (*Figure 5*). Each block of information (eg, "Patient Presentation," "Initial Clinical Interview," etc) is printed on a separate sheet of paper that facilitators can distribute to students as needed. In most cases, information is presented in approximately the same sequence as would become available to a practicing physician over time. However, student discussion of the case and their readiness for specific information ultimately determines when it will be disclosed.

Group-Tutorial Process

At the first group-tutorial session, regardless of semester, students and facilitators briefly introduce themselves. This provides an opportunity for all to gain a common understanding of expertise within the group and any potential factors that might affect group process (eg, students in a group with someone who has a pharmacy degree and work experience may expect him or her to explain a pharmacy-related learning issue without looking up the information for themselves). At this first session and in all subsequent sessions when a new case is introduced, specific responsibilities are assigned, chosen, or volunteered depending on how the group has decided to operate. The "scribe" records information on a "blackboard" as the case unfolds, a "reader" reads each page of information as it is distributed, and a "patient" and "physician" role-play the process of taking the oral history. Roles are rotated with each case.

The group-tutorial process can be divided into three phases. In the first phase, the reader reads each page as it is distributed while the scribe records information gleaned from the reading. The blackboard is divided and labeled according to various headings (eg, "facts," "general ideas," "questions," "hypotheses," and "learning issues"). The students first discuss the facts and determine which are important and which are irrelevant, and then they probe for scientific explanations and correlative information relating to the clinical picture that emerges. Group members use their existing knowledge to initiate discussion. In addition, students are also encouraged to look up additional information in available resources (eg, books brought by individual students, the Internet).

Learning and understanding the basic science mechanisms associated with clinical symptoms and signs—not diseases—is the primary goal of PBL. This goal—not "making a diagnosis"—must constantly be maintained throughout the group-tutorial process. It is also important to the learning process to maintain an "osteopathic" approach and to assess any

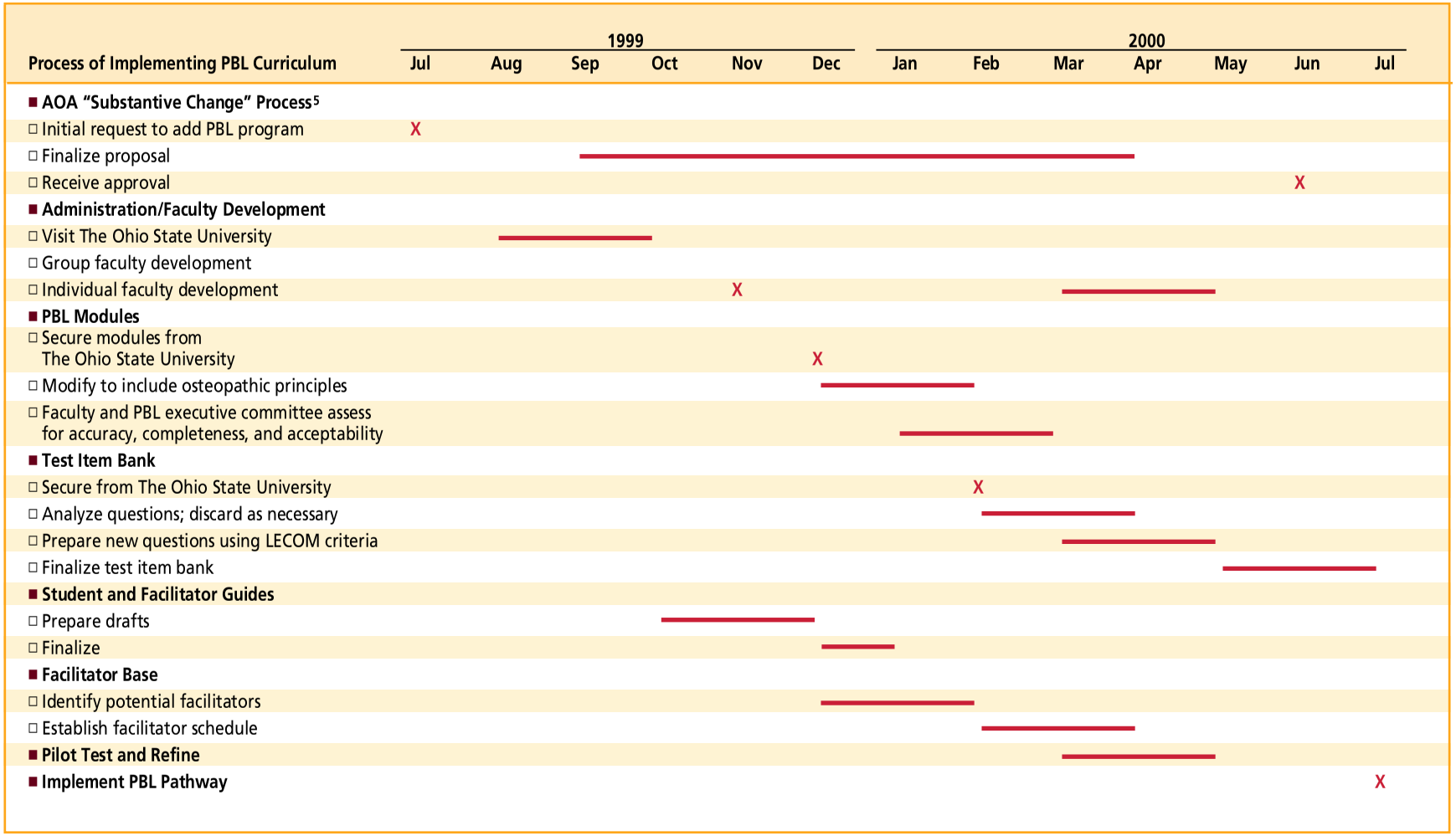

Figure 4. *Outline of the process of adapting a problem-based learning (PBL) program for Lake Erie College of Osteopathic Medicine (LECOM) in Erie, Pa, based on a model used by The Ohio State University in Columbus. Lines indicate approximately when specific steps began and when they were completed. Steps that did not span a number of months (ie, were completed within 1 month) are indicated by X.* ***Abbreviation:*** *AOA, American Osteopathic Association.*

osteopathic learning issues that may be relevant to each case.

Facilitators should always encourage students to challenge each other—and the information presented regarding basic accuracy and their own understanding. With regard to group dynamics, it may be difficult in the early stages of the process for students to challenge—and be challenged by—others in a constructive manner. Initially, they may feel personally insulted by such challenges. However, as students' clinical and interpersonal skills and their familiarity with each other increases, we have found that these challenges usually become an enjoyable aspect of the process and help students—individually and collectively—focus on areas where knowledge must be gained.

As the number of items listed in the various headings grow and as the process is repeated through the subsequent distribution of blocks of information, students begin to formulate testable hypotheses. To do this, students predict what might be on the next page or pages by asking questions such as:

- What should be done in the physical examination and what are the anticipated findings?
- What tests should be ordered and what findings are expected?
- What treatment should be implemented and what are the predicted outcomes?

In the process, learning issues are identified. Learning issues should be selected by the group in response to the need to answer a general question. Specific questions such as "What does the first heart sound represent?" are not as helpful in determining learning issues as a more general topic. For example, a more global topic related to "all heart sounds" or "the cardiac cycle" would be more appropriate. In addition, learning issues should be relatively complete topics representing a body of information within which the answer to a specific question related to the learning issue can be found (eg, a specific chapter of a textbook).

At the conclusion of each session, the group decides which learning issues to pursue and which resources might be the most useful. Also, time should be allotted for students and facilitators to evaluate the session (eg, what was beneficial, what might have made the session more productive).

During the second phase, the students independently address the learning issues adopted at the conclusion of the preceding group session. In other words, students engage in independent study by using resources such as textbooks, journals, microscope slides, radiographs and other scans, audio-visual materials, the Internet, and even faculty to learn information regarding previously determined learning issues. Students are encouraged to work together, and communication between and among members of different tutorial groups is allowed.

During the third phase, which occurs at the next scheduled group-tutorial session, students share and discuss what each has learned. Students then use their new knowledge to evaluate previously posited hypotheses. Often the session begins with a student—selected or volunteer—presenting the case as it was left in the last session as though presenting to an attending physician.

In light of new information, the students continue discussing the case, list new ideas, formulate new hypotheses, and identify new learning issues. This is followed by another group self-evaluation at the end of the session, another period of independent study, and additional group-tutorial sessions, as necessary. This process is repeated until the students are satisfied that they have gained sufficient knowledge of the basic scientific concepts that are necessary to understand the mechanisms underlying the clinical picture presented in the case. Subsequently, the group evaluates its activities, summarizes what has been learned, and determines which learning issues to submit to the PBL administrative office for possible inclusion in future testing.

Program Evaluation

Students' test results and other measures of progress (eg, facilitator and peer evaluations) through the curriculum are monitored, assessed, and evaluated for trends that might indicate needed modifications to the PBL pathway. Processes and strategies for evaluation are identical to those used in the traditional and independent study learning pathways. For

- ■ **Patient Presentation**
- □ Name*
- □ Sex
- □ Age
- □ Chief complaint
- ■ **Initial Clinical Interview**
- □ Answers to anticipated questions
- □ History of present illness
- □ Medical and surgical history
- □ Social and family histories
- ■ **Physical Examination**
- □ Vital signs
- □ Results of appropriate systemic examinations
- ■ **Additional Patient Information**
- □ Diagnostic and laboratory results
- □ Other relevant facts and findings
- ■ **Diagnosis and Treatment**
- □ Statement of diagnosis
- □ Treatment and management
- □ Information regarding any follow-up with patient

Figure 5. *Standard format of each module of the problem-based learning pathway at Lake Erie College of Osteopathic Medicine in Erie, Pa. Each block of information is printed on separate sheets of paper, which allows facilitators to distribute discrete amounts of information from the module at any given time. "Additional Patient Information" may consist of several blocks of information, and therefore, that information would appear on separate sheets of paper. *Anecdotal patient names are assigned for all cases.*

example, students in each of the three basic learning pathways are tested on a regular basis on established amounts of material (*Figure 1*). All students (ie, first-year and sophomore students in all three learning pathways) complete questionnaires regarding their satisfaction with their respective learning pathways. Quantitative and qualitative responses are summarized and reported to the institutional committees responsible for the curriculum and student performance. All sophomores, regardless of designated learning pathway, are required to pass the Level 1 Comprehensive Osteopathic Medical Licensing Examination.

As previously indicated, we intend the three basic science learning pathways to be equivalent regarding graduates' summative competencies. Over time, and with confounding variables removed, we expect no significant differences in comparisons of group-based performance regardless of curricular pathway. To position ourselves to assess this expectation, we have developed parameters for a longitudinal database (*Figure 6*). As resources allow, we are populating the database with data collected since students first graduated from LECOM in 1997. The longitudinal database will soon be a viable resource for a variety of studies relative to LECOM's three basic science learning pathways. We are committed to comparative studies of any combination of learning pathways only if data is available for 5 years of any given learning pathway.

Much interest in such studies exists as evidenced by three landmark reviews[2,4,9] that examined the effectiveness of PBL compared with traditional learning. Few studies exist of a similar nature regarding comparing the independent study pathway and the traditional pathway; we found two.[3,10] Studies comparing PBL and independent study or PBL, independent study, and traditional study are not available, and, of all studies found regarding medical education learning pathways, the number reported in the osteopathic medical education literature is minuscule.[1,11]

Comment

Adoption of PBL into medical school curricula has been a worldwide phenomenon. After its introduction in the mid-1960s at McMaster University in Hamilton, Ontario, Canada,[12] an estimated 60 medical schools worldwide had espoused PBL in whole or in part by the early 1990s.[13] By 2000, an estimated 10% of medical schools worldwide had adopted PBL in some form.[14] Not surprisingly, PBL has been described as one of the most comprehensive innovations in medical education since the Flexner Report.[2,15] While PBL curricula tend to occur most frequently in the first 2 years of medical education, numerous examples exist of PBL in the final 2 years of medical school.[16-20]

Given the growing prevalence of PBL as a learning pathway, it is not surprising that medical education literature demonstrates longstanding interest in whether differences exist between students who complete PBL pathways compared with those in traditional lecture-discussion pathways. The most frequently questioned and compared elements include attitudes, basic and clinical science knowledge, and clinical competencies.[21-23]

Although most studies[21-27] report data favoring PBL over traditional learning pathways, some studies favor the traditional learning format over PBL,[28-30] particularly when basic science examinations are being compared. However, some

- **Admissions**
  - Baccalaureate education
    - Academic major
    - Demographics
    - MCAT scores
    - Science GPA
    - Nonscience GPA
- **LECOM**
  - First year
    - Gregorc style delineator
    - Grades
    - GPA
    - Questionnaire
  - Second year
    - COMLEX-USA Level 1
    - Grades
    - GPA
  - Third year
    - Clerkship rating (grades)
    - GPA
  - Fourth year
    - COMLEX-USA Level 2-CE
    - COMLEX-USA Level 3-PE
    - Clerkship rating (grades)
    - GPA
    - Final rank
    - Questionnaire
- **Postgraduate**
  - Internship and residency training
    - Specialty
    - Training institutions
    - Geographic location
    - Performance ratings
    - COMLEX-USA Level 3
  - Beyond residency
    - Practice specialty
    - Practice location
    - Practice type
    - Board certification
    - Follow-up questionnaire

Figure 6. *Data fields in the longitudinal database at Lake Erie College of Osteopathic Medicine (LECOM) in Erie, Pa. Data collection will be used to compare the three learning pathways currently used at LECOM: traditional lecture-discussion, independent study, and problem-based.* ***Abbreviations:*** *GPA, grade point average; CE, clinical evaluation; COMLEX-USA, Comprehensive Osteopathic Medical Licensing Examination; MCAT, Medical College Administration Test; PE, performance evaluation; PGY-1, first year of postgraduate training; PGY-2, second year of postgraduate training.*

studies[21,23] may have been conducted prematurely, involving only the first few classes to complete PBL at the particular school where the study was conducted. As a result, studies comparing the three pathways at LECOM will not be made until at least 5 years' worth of data is available for analysis.

Two studies[3,10] comparing the independent study and traditional learning pathways support these plans. The studies,[3,10] which were conducted at the same institution and were based on 10 years of data, reported that student outcomes of the two programs were more alike than different. Specifically, students pursuing the independent study program and students in the more traditional program performed similarly on Part I of the National Board of Medical Examiners tests and in the required clerkships.[3,10] These studies also reinforce our expectation that LECOM's three distinct basic science learning pathways will be similar in students' overall learning outcomes.

The current study has discussed three key elements of curricular program development: (1) the means used at LECOM to introduce a PBL pathway in the first 2 years of medical school, (2) PBL as we have implemented it at LECOM, and (3) a longitudinal database to be used to evaluate PBL outcomes and to compare with those of the lecture-discussion and independent study learning pathways. The longitudinal database has positioned LECOM to study problem-based, independent study, and traditional learning pathways in various combinations regarding implementation and outcome issues.

Conclusion

The PBL pathway at LECOM allows students to participate in a combination of small group and independent study activities. Students' studies are based on learning issues defined by their respective small groups as a result of collective work on cases presented in a modular format. A major goal of this pathway is to provide medical students with rigorous learning opportunities in a less structured environment than normally possible with the more traditional curricular pathway. The PBL pathway is more similar to the environment that they will experience as competent, life-long, self-directed learners. It is expected that future studies comparing LECOM's three learning pathways—traditional, independent study, and problem-based—will reveal their value in osteopathic medical education.

Acknowledgment

The authors gratefully thank PBL Program Director W. Richard Chegwidden, PhD, FRSC, at LECOM in Erie, Pa, for advice and counsel to ensure that the descriptive elements of the article were both accurate and current.

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The largest medical school in the nation, the Lake Erie College of Osteopathic Medicine and School of Pharmacy mission is to prepare students to become outstanding osteopathic physicians and pharmacy practitioners through programs of excellence in education, research, clinical care, and community service to enhance the quality of life through improved health for all humanity. The primary goal of LECOM is to educate students to become physicians practicing within the osteopathic concept. A secondary goal of the College is to educate and develop primary care physicians who will practice in the o... Graduation Year: 2020. â€œ Lake Erie College of Osteopathic Medicine is wonderful to offer 3 distinct campuses with unique programs at each. At Seton Hill's campus, I am fortunate to learn not solely in a didactic/lecture format, but the core of our sciences curriculum stems from case files designed to simulate ER, Primary Care, or Specialist visits. It allows us to work on our differential, research, laboratory, and diagnostic abilities and skills. This problem based method, in my opinion, will not only provide a useful tool to review for our Boards certifications (COMLEX), but also for fu Learn more about Lake Erie College of Osteopathic Medicine, and see if it is the right school for you. Get information on student diversity, cost and more.Â Want the scoop on Lake Erie College of Osteopathic Medicine? We've put together a comprehensive report on the school that covers what majors LECOM offers, how the school ranks, how diverse it is, and much more. If you're interested in learning more about a particular stat, just click on its tile to go to a new page that covers the topic more in-depth. Also, you can jump to any section of this page by clicking one of the links below. Rankings.