

PBL in the Undergraduate MD Program at McMaster University: Three Iterations in Three Decades

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Abstract

When the undergraduate MD program of McMaster University admitted its first cohort of 20 students in 1969, it heralded a major change in medical school pedagogy that has influenced the education of medical students around the world. The three-year PBL curriculum, which emphasized small-group tutorials, self-directed learning, a minimal number of didactic presentations, and student evaluation that was based almost entirely on performance in the tutorial, represented a radical departure from traditional curricula. Since the inception of the original curriculum in 1969, there have been two major curriculum

revisions, the most recent of which was in 2005. The original curriculum attempted to integrate both basic science and clinical science into the biomedical problems. The second iteration of the curriculum focused on priority health problems and centered on a list of common medical problems as the foundation for curriculum organization, on the basis that an understanding of the management of common conditions included areas of knowledge that would be essential for clinical competence. Under the third, current curriculum, the COMPASS (concept-oriented, multidisciplinary,

problem-based, practice for transfer, simulations in clerkship, streaming) model was adopted. Under this concept-based system, emphasis is placed on underscoring the underlying concepts in the curriculum with a logical sequencing of both the concepts and the body systems. This article briefly reviews the history of the development of the undergraduate MD program at McMaster and the three curricula that have been developed during the past three decades.

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In 1964, the Ontario provincial government made public a commitment to finance a new medical school in Hamilton. There were several reasons for this commitment. First, the 1960s were times of rapid expansion in population and in postsecondary education, with the baby boomers entering universities. The provincial government was committed to adding a fifth medical school. Hamilton was chosen as the site for a number of reasons: geographic location, the existence of a thriving research-intensive university and proximity to other universities in southern Ontario, and a strong clinical community with a long history of educational involvement. In 1965, the university appointed Dr. John Evans, then a 35-year-old faculty member

in the department of medicine at the University of Toronto, as the founding dean of McMaster Medical School. Over the next year, a number of pivotal faculty appointments were made of visionary individuals who became the founding fathers of the new medical school. It was clear from interviews with the original faculty that they were anxious to try something really different: to get away from passive lectures involving monotonous transmission of facts and to move toward active involvement of students in their own learning. The faculty determined that, although knowledge of biology and biochemistry would be a requirement for all students seeking entry, admission would be governed primarily by the quality of applicants' undergraduate performance, with only secondary consideration given to the principal area of undergraduate study. The decision to offer a three-year medical course would permit students to receive their MD degree one year sooner, thus saving living and tuition expenses and increasing their vocational life span by one year.¹ The faculty felt that this would be an attraction to older, more experienced students impatient to qualify in medicine. A shorter course, however, acknowledged that skills in practice or research would be highly dependent on

the education and training that took place after medical school graduation.

The first class, which matriculated in 1969, had 20 students, but class size rapidly increased to 100 students over the next few years, and it has remained at 100 until 2004, when it was increased to 140. The number of full-time faculty in health sciences has, by contrast, increased continuously, although at a decreasing rate, from 81 full- and part-time in 1968, to 417 in 1973, 675 in 1978, and about 1,600 today. (Of course, the medical school is only one of many research and educational programs within the faculty of health sciences.)

The First Steps toward PBL at McMaster

When the medical school opened in 1969, the curriculum planners were very concerned about the explosion of biomedical knowledge, and they set out to educate a graduate who had the skills to deal with the information explosion through self-directed learning, information search and retrieval skills, critical appraisal, and self-assessment. The curriculum was designed to open with an integrated approach to the problems of human biology dealing with

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normal structure and function and a knowledge of the basic tissue and system reactions that lead to abnormal structure and function. The integrated approach would be an alternative to conventional medical courses, in which most of this information was taught in separate courses of anatomy, physiology, and general pathology. It was envisioned that the remainder of the curriculum would consist of a continuous 80-week period of professionally oriented programs in clinical medicine presented primarily in the university hospital.¹

The three key features that subsequently became known as “the McMaster philosophy” were self-directed learning, PBL, and small-group tutorial learning. The origin of these three elements is somewhat clouded in history, but the use of tutorial cases was an attempt to adapt the case study method of Harvard Business School (HBS) to medicine (one founding father had a colleague at HBS). Self-directed learning was popularized by Malcolm Knowles in a popular book of the time. Tutors and small-group learning seem to have been an attempt to emulate the Oxford/Cambridge tutor system.

The program goals as espoused by the original faculty for the first iteration of the McMaster curriculum were as follows:

1. To identify and define health problems and to search for information to resolve and manage these problems.
2. Given a health problem, to examine the underlying physical or behavioral mechanisms.
3. To recognize, maintain, and develop personal characteristics and attitudes required for professional life.
4. To develop the clinical skills and learn the methods required to define and manage the health problems of patients.
5. To become a self-directed learner.
6. To be able to critically assess professional activity related to patient care, health care delivery, and medical research.
7. To be able to function as a productive member of a small group.
8. To be aware of, and be able to work in, a variety of health care settings.

In defining PBL at McMaster in 1974, just five years after the school had

opened, Neufeld and Barrows,² who both had joined the faculty in 1970 and were not part of the original design but did much to popularize the method, wrote that “learning based on problems represented an alternative to studying blocks of classified knowledge in a strictly organized sequence.” In PBL, the learner focused on a problem that he or she had identified and that involved genuine intellectual effort. The learner brought to the problem all of his or her previous information and expertise as well as an ability to think rationally about it. Neufeld and Barrows² felt that the PBL approach contributed to a student’s motivation by encouraging active intellectual processes at the higher cognitive levels, enhancing the retention and transfer of information and modifiable to meet individual student needs.

Maintaining the Philosophy but Changing the Curriculum

Two major curriculum revisions have taken place in the undergraduate MD program at McMaster University since the inception of the first curriculum in 1969. The first major revision occurred in 1983 with the development of the priority health problem curriculum. The most recent complete revision of the curriculum occurred with the introduction of the COMPASS (concept-oriented, multidisciplinary, problem-based, practice for transfer, simulations in clerkship, streaming) curriculum in September 2005. The basic tenets of each of these three curricula will be described, and the pedagogical rationale for the three curricula will be contrasted. However, despite major curricular revisions made in the past 35 years, some fundamental aspects of the original philosophy of the founding fathers have remained constant. Many of the original eight program goals have remained intact despite some reframing and changes in the relative emphasis on each one. This will become clear as each of the three curricula are described in more detail. Today, as in 1969, the emphasis remains on small-group tutorials and on PBL as the main focus of student learning in the curriculum (despite a menu of lectures), with faculty-led resource sessions, clinical pathological conferences, and clinical skills sessions to round out the timetable. Over time, there have been major

changes in student evaluation, the role of the tutor, and the number and purpose of didactic sessions.

The first curriculum: Biomedical problems

During the first curriculum, the three-year program consisted of four phases. The first two were 10 weeks each, and the last two were one year each. Phase I was an introduction to the community, with issues related to population health. There was also an introduction to the learning strategies related to problem solving, independent study, and the small-group tutorials. Students were also introduced to universal concepts in structure, function, and behavior, and some basic clinical skills.

The second phase concentrated on the body’s response to various stimuli using basic pathophysiological models such as ischemia, inflammation, or even reactive depression. The third phase was structured around four 10-week combined organ system units. Phase IV consisted of the clinical clerkship and comprised three major blocks: hospital based, ambulatory, and elective. Approximately 25 weeks of this three-year, 130-week curriculum were designated for electives. Students tended to use these periods for pursuing individual interests, gaining an opportunity to study at other medical schools, or covering areas in which they felt they might have deficiencies.

There were virtually no didactic lectures presented to students in this first curriculum, and the emphasis in the tutorial was on biomedical problem solving. Neufeld and Barrows² defined a series or sequence of steps that students should take in working through a biomedical problem, from translating questions of structure, function, and behavior through the development of learning objectives, identifying educational resources, and seeking, assessing, and then synthesizing information to bring back to the problem at the next tutorial for an explanation of the biomedical problem.

Student evaluation took place in tutorial and was derived from input from self, peer, and tutor. Students were not required to sit written examinations at the end of any particular block of curriculum. The tutors played an

important role in student evaluation under the first curriculum, but they were not required to have any particular content knowledge of the material under discussion in the tutorial, other than that provided in the tutor guides for the biomedical problems. At that time, it was felt that content experts would be overly tempted to lecture to the students in tutorial, detracting from the students' opportunity to bring to bear any prior knowledge or understanding that they might have to tackle the biomedical problems facing them in the tutorial.

Although the curriculum was described as "self-directed," a large number of educational resources were identified for each of the biomedical problems. Print resources, primary book chapters, and audiovisual resources (slide-tape shows) accompanied each problem. Students had multiple-choice self-assessment questions to check on their understanding. Detailed problem objectives were available for each problem. In addition, resource faculty were identified who could be contacted to help any particular group who, despite reading the relevant resource materials, still felt they did not understand the underlying biomedical problem.

Inherent in the pedagogical philosophy of this first curriculum was the concept of spiraling through the same content area several times throughout the program; thus, a basic issue around structure and functional behavior introduced in phase I would be studied in more detail in phase II in the context of a pathophysiological process, the clinical manifestations of which would be discussed in more detail yet again in phase III and then in the clinical setting during the clerkship in phase IV.

The curriculum eschewed the classical medical school curriculum of sequenced individual basic science courses followed by clinical science courses and clinical clerkships. Instead, it attempted to integrate both basic science and clinical science into the biomedical problems. The curriculum challenged the assumption that students required a broad-based basic medical science foundation before they could begin problem solving around clinical biomedical problems.

The second curriculum: Priority health problems

In the early 1980s, the medical education literature reflected an increasing interest

in the essential knowledge, fundamental skills, and personal qualities, values, and attitudes required for the general professional education of physicians. An essential element in the development of learning objectives for several schools as they redeveloped their curricula at this time was the use of a list of common medical problems as the foundation for curriculum organization. The thesis was that an understanding of the management of common conditions included areas of knowledge that would be essential for clinical competence.

The faculty at McMaster were inspired by the increasing interest in population health. Accordingly, widespread polling of the larger faculty in all departments was conducted to identify priority health conditions that should form the basis of a revised curriculum.³ The curriculum that was developed in 1983 was divided into a number of units—a change in terminology from "phases." Although a body-systems approach was taken to structuring the preclerkship curriculum, the major philosophical change from the first biomedical curriculum was the laying out of all the basic and clinical sciences around priority health problems. These health problems were chosen on the basis of prevalence, clinical logic (i.e., the problem had important value for clinical problem solving), prototypic value (i.e., a rare condition might be an excellent model for study), threat to life (i.e., immediate intervention is required at the time of presentation), treatability, and interdisciplinary learning potential. Health problems and conditions were classified according to the frequency distributions of the weightings assigned for each of the six criteria just described. Many faculty were polled to weight these conditions, and the level of agreement was recorded. Whereas the fundamental biomedical issues were central in the first iteration of the curriculum, the priority health problem curriculum required students to identify the basic science areas for study to answer the questions posed by the clinical problem and to study these basic sciences to a level that would help them explain the clinical issues raised by the tutorial problem.

When the change to a priority health problem curriculum was made, other aspects of the undergraduate MD program remained unchanged. Tutorial learning continued to be emphasized,

with students in small groups of five or six students per group, with a preference for nonexpert tutors, and no formal written examinations at the end of blocks of curriculum.

The priority health problem curriculum began with a 16-week block of introductory material covering a host of topic areas and crossing a number of different body systems, allowing students to gain some understanding of the three major perspectives that defined the objectives of the curriculum: biological, behavioral, and population health. The succeeding units then became body-systems units comprising cardiovascular/respiratory and renal; gastroenterology/hematology and endocrinology (known affectionately as "blood and guts"); locomotor/nervous system and behavior; and, finally, a life-cycle unit on reproduction/human development and aging. At this point, after about 20 months in medical school, the students entered a clerkship that was not significantly different from that structured in the first curriculum.

A number of structural changes were made to the priority health curriculum between its inauguration in 1984 and the most recent curriculum change in 2005. Along the way, the last preclerkship unit on the life cycle was removed, and its material was integrated into both the early parts of the preclerkship and several parts of the clerkship, which then started three months earlier. This curriculum change was made to allow McMaster students to complete more of their core clerkships before requiring them to make decisions about residency training. The clerkships in family medicine, obstetrics–gynecology, pediatrics, and psychiatry were lengthened, and a new rotation in anesthesia was developed. In 1991, the personal progress index examination was introduced to emphasize to students that, irrespective of the enjoyment of learning in tutorial, the acquisition of a progressively sophisticated medical knowledge base was required for successful graduation from the program. In addition, in 1995, the clinical reasoning exercise, a short-answer examination based on curriculum content, was introduced at the end of each preclerkship unit.

The third curriculum: COMPASS

Many faculty at McMaster were comfortable with the small-group tutorial

PBL curriculum, which graduated students with performance on the national licensing examination near the national average and a first-round match on the Canadian residency match, which was well over 90%. However, careful review of comments from internal McMaster MD program exit surveys suggested that there were concerns about the priority health problem PBL curriculum. By the late 1990s, a number of reviews of PBL medical school curricula had been published,^{4,5} and some faculty at McMaster became concerned that the skills that medical school graduates would need for the new millennium were not necessarily reflected in the curriculum. The area of greatest concern was students' assimilation of fundamental basic science concepts.

It was recognized that although the priority health problem tutorial cases had these basic science concepts embedded within them, the rich clinical contexts of these cases allowed students and tutors alike to concentrate more on the clinical aspects of the case than the fundamental mechanisms. Indeed, although the long clinical cases were replete with potential learning objectives, it was certainly difficult for some students to prioritize

these learning objectives, even with the facilitation of their tutors. In addition, students were reporting that insufficient attention was being paid by their tutorial groups to learning objectives in behavior and population health, and tutors often seemed ill prepared to help students identify how much emphasis should be placed on behavior and population perspectives. Subjectively, students seemed more comfortable when they were identifying biological perspective objectives in the tutorial cases. Planners in the McMaster MD program began to recognize that there were clear interrelationships between conceptual knowledge and clinical performance. The cognitive psychology literature was extensively reviewed, and among those who began working on the new COMPASS curriculum, the working assumption developed that emphasis should be on underscoring the underlying concepts in the curriculum with a logical sequencing of both the concepts and the body systems. In this way, true integrated learning could become a reality. Thus was born the concept-based curriculum.

There are many differences between the COMPASS curriculum and the curricula

that preceded it. The undergraduate MD program continues to have a 130-week, 33-month curriculum with a focus on small-group tutorial PBL. However, the preclerkship curriculum is arranged around conceptual themes such as oxygen supply and delivery. Students cover much of the respiratory, cardiovascular, and hematological systems by studying problems around oxygen delivery, but the strict body-system curriculum walls are more porous in the new curriculum. A further innovation in this curriculum iteration is the introduction of a professional competencies curriculum that runs horizontally across the entire curriculum, with weekly group meetings in the preclerkship covering concepts such as ethics and moral reasoning, law, epidemiology, communication, and clinical examination skills, as well as professional development and self-reflection. The clerkship contains a new rotation in emergency medicine.

The COMPASS curriculum, which is Web based, has been designed for dissemination via an electronic platform, allowing it to be distributed to separate medical school campuses that are being developed in association with McMaster.

JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC			
								Professional Competencies		ORIENTATION	MEDICAL FOUNDATIONS 1 INTRODUCTION TO DETERMINANTS OF HEALTH CARDIO/RESP/HEME		INTEGRATION	VACATION
								Professional Competencies						
		MEDICAL FOUNDATIONS 3 HOMEOSTASIS II RENAL, ACID BASE, BP REPRODUCTION AND PREGNANCY GENETICS I		MEDICAL FOUNDATIONS 4 HOST DEFENSE NEOPLASIA GENETICS II		ELECTIVE		MEDICAL FOUNDATIONS 5 MOVEMENT CONTROL INTERACTING AND COMMUNICATING		INTRO TO CLERKSHIP INTEGRATION	ELECTIVE	VACATION		
Professional Competencies								CLERKSHIP (2 weeks vacation sometime in June/July)					VACATION	
Professional Competencies														
ELECTIVE	CLERKSHIP												SYN1 + LMCC LECTURES	

Figure 1 Outline of three-year COMPASS undergraduate MD curriculum.

As evidence has mounted that effective learning and transfer of concepts requires feedback from mentors or tutors, greater emphasis has been placed on recruiting tutors with content knowledge of the curriculum. Tutor guides are thus prepared according to a more formal template that provides tutors with the explanations for the underlying concepts in the tutorial case and with probing questions to help keep students on track if the tutorial discussion becomes tangential. The rich, long, multiobjective cases have been replaced by more focused, shorter cases, allowing students to tackle important issues from more than one situation or clinical scenario.

There are also more didactic sessions in the new curriculum than in the two previous ones. The goal here is not to provide students with content lectures on material that could just as well be discussed in tutorial or read out of a book, but to allow faculty to give introductory or wrap-up overviews in areas where there might be anticipated difficulty for students facing such concepts for the first time. Clinical pathological conferences chaired by both a clinician and a pathologist are given monthly throughout the preclerkship. The organizing themes and their layout throughout the curriculum are depicted in Figure 1.

The Three Curricula: What Do the Changes Really Mean?

Despite the two major curriculum revisions that have occurred since the inception of the undergraduate MD program at McMaster in 1969, as well as some reframing in the terminology, the graduating competencies expected of the McMaster graduate remain essentially the same. Although the words and phrases familiar to medical educators these days found in the Canadian Royal College of Physicians and Surgeons CanMEDS roles⁶ or the Accreditation Council for Graduate Medical Education six competencies⁷ were not those used in the 1960s, the eight general goals of the MD program from the original curriculum can be mapped remarkably closely to the CanMEDS roles we currently expect of our graduating students from the COMPASS curriculum. For many at McMaster, the return to an emphasis on fundamental underlying concepts, even in the context of a patient-centered tutorial case, represents a return to the roots of the original curriculum. To the extent that fundamental principles are emphasized in the COMPASS curriculum, there is some similarity to the biomedical approach taken in 1969. However, the integrated sequential organization of the conceptual themes allied to the professional competencies curriculum embraces all that McMaster

faculty have learned from their own experience, from reviewing the experience of PBL education around the world, and from cognitive psychology's impact on education. The curriculum at McMaster will continue to evolve in response to societal needs, the needs of our students, and the evidence we obtain from studying what we do.

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Did You Know?

With federal funding from the National Institutes of Health, researchers at Vanderbilt University Medical Center and Duke University Medical Center identified, in 2005, the first major gene that increases a person's risk for developing age-related macular degeneration.

For other important milestones in medical knowledge and practice credited to academic medical centers, visit the “Discoveries and Innovations in Patient Care and Research Database” at (www.aamc.org/innovations).