

Problem-Based Learning (PBL) in Teaching Physiology and Pathology

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Abstract

In the first part of this project, an expert teaching consultant from McMaster University (Hamilton, Ontario, Canada) was called upon to introduce and promote problem-based learning (PBL) in Physiology and Pathology with a special emphasis on a small group, self-directed approach. The situation for active learning in the two departments and the perception of the faculty and students on problem-based learning in small group settings have been presented. The consultant concludes that Hong Kong medical students can do well with PBL if given appropriate guidance and encouragement. Recommendations have been made for the design, implementation and evaluation of PBL tutorials in Physiology and Pathology. The initiative of this project has contributed partly, but in a significant way, to a recent move by the Faculty of Medicine of the University of Hong Kong toward an innovative reform of the medical curriculum. In the second part of this project, departmental coordinators visited McMaster University to acquire the first-hand information and experience the of small group, self-directed, PBL approach in medical education. Visits were also made to the School of Medicine of Southern Illinois University and the College of Medicine of the National Taiwan University, which have successfully adapted and committed to the use of PBL as a major learning/teaching approach in medical education.

PBL and Medical Education: An Introduction

Medical education is concerned with training medicare professionals to have appropriate attitudes and a sense of value. It also trains them to be capable of critical appraisal, decision-making and adaptation to change, and to develop efficient learning, effective communication, team-spirit and sometimes, risk-taking. The practice of medicine is generally seen as community-based, self-motivated, team-facilitated and problem (clinically)-oriented, requiring understanding of the processes of integration of information and skills. Are we training our medical students in these skills in a learning environment reflecting that of physicians in the medical practice? The answer is NO. The learning of medicine by students in Hong Kong has traditionally been viewed as the learning of biological sciences in highly compartmentalized packages (Anatomy, Physiology, Biochemistry, Pharmacology, Microbiology, Pathology, etc.). A good medical student is generally viewed as one who gets high marks in a large number of written examinations and tests which assess students' retention of learned factual material provided by the teachers. At McMaster University, when the Faculty of Health Sciences was formed three decades ago, the intention was to produce graduate physicians who would be:

- good problem-solvers
- life-long learners
- team-players
- good communicators.

The above personal and professional qualities of the graduate physicians could be effectively fostered via an innovative curriculum in medical education — the problem-based learning (PBL) approach, in which the learning environment simulates the professional environment. Should we change the way we educate our medical students, who will be our future health caretakers in this community? The answer is YES. With the above personal commitment, C.Y. Kwan's 16-year McMaster background, the helping hands of the dedicated teachers from the Departments of Physiology and Pathology and the generous support of the ALP grant award, the first step has been taken via the Action Learning Project (ALP) to explore the possibility of introducing PBL as an effective means of professional training in medical education at the University of Hong Kong.

Although PBL was first introduced to the Department of Physiology at the University of Hong Kong when C.Y. Kwan joined this department as the Chair Professor and Head in the academic year 1992/93, teachers' concept of PBL remained quite vague and the students resisted PBL because it was not the way in which they were used to learning. We realized that a proper introduction of PBL to our teachers, in both the preclinical and clinical departments, was an essential first step. In the first part of the ALP project in 1994/95, we invited a teaching consultant, Professor Robert Lee, from the Department of Anaesthesia at McMaster University to come to the University of Hong Kong to introduce the medical educational management system and educational philosophy of PBL which has been in practice, evolving and improving, at McMaster for the past three decades. Workshops on PBL and small group tutorials were organized, in which most of the teachers in the two Departments participated. These events were accompanied by consultation group discussions and meetings, followed by seminar presentations to other Departments and Faculties. The overall progress has been presented as an interim report submitted to the ALP. During this period, the new Dean of the Faculty of Medicine, Professor S.P. Chow, has also announced his intention to reform undergraduate medical education. Coordinators of this ALP team have served as advisors and consultants to the Dean. It became increasingly clear that coordinators in this ALP team could contribute much more effectively and constructively to the reform process if they had the opportunity to visit McMaster University and other institutes practicing the PBL approach in medical education to get first-hand up-dated information and experience in PBL. The second half of the ALP therefore reflects our reaching-out efforts. The observations, comments and recommendations of the ALP team are summarized below.

PBL and McMaster Medical Education: A Pioneering Effort

Both L.C. Chan and J.M. Nicholls visited McMaster University under the coordination of Professor Robert Lee, Department of Anaesthesia and Chairman, Unit 2 of the MD programme, who visited Hong Kong in February 1995 as a Teaching Consultant for our Action Learning Project. We were able to meet several members of staff, participate in a student tutorial and were shown some of the resources available at McMaster for the PBL medical curriculum. Owing to time constraints we were not able to visit hospitals other than McMaster where bedside teaching and ward work are carried out. Although our visits were limited in duration, we were nevertheless able to identify some of the main issues involved in the medical curriculum in McMaster:

Characteristics of PBL in the Tutorial Group Setting

We were impressed as well as stimulated by how effective PBL helps students to achieve the following objectives:

- *Self Directed Learning:* Throughout the tutorial it was evident that the students were the ones who had done the work and they were the ones who formulated the goals and objectives for the tutorial. At the beginning of each session an agenda and goals would be written on the blackboard for how the tutorial would run. This was sometimes done in the absence of a tutor.

- *Team Work:* The students worked together and at the end of a tutorial there would be a cooperative delegation amongst the students as to who would look up what subject and prepare the next topic. Even with a small group size of six students it was still noticed that some participated more than others in the tutorial, which the tutor would occasionally need to mention at the end of the tutorial.
- *Problem Solving:* The problems which were presented were not rare ones but ones which represented common diseases in the population. Though a recommended list of issues was in the tutors guide, the students rarely covered all these issues. However, the problems which they did tackle were handled well.
- *Communication Skills:* The students were very good at listening to one another and picking up non-verbal signs from other members of the group.

The students we met were graduates and came from a variety of backgrounds, i.e., science and arts. Interestingly, such heterogeneity in student background did not seem to pose much of a problem in their learning process.

Resources in Support of PBL

A wide range of resources, e.g., trained tutors, clinical perceptors, laboratory and other material resources (e.g., laboratories), are necessary to support the programme based on PBL. The morphology laboratory in which anatomical specimens are displayed together with other teaching aids including radiographs, is innovative for learning anatomy in the context of medical problems. Significantly, the design of the morphology cases is based upon the clinical problem studied by the students so that they are able to see the relevance of basic sciences to their clinical problems. We were also impressed with the clinical skills laboratory which is well equipped to facilitate students in acquiring basic clinical skills, e.g., listening to heart sounds, examination of abdomen, etc.

Very importantly, there is adequate space allocation set aside for tutorials. The rooms in which the tutorials were held are open, comfortable and quiet. They all include a white board on which goals are written on and the occasional diagram given. Within the library there is an adequate computer facility though J.M. Nicholls noted that most of the terminals are used for literature searching. The stock of audiovisual material is very dated and a limited number of interactive multimedia presentations are available.

Setting Group and Individual Objectives in PBL Learning

Very clear goals and objectives are set for both teachers and students. Individual learning objectives are balanced by the collective group learning objectives via collegial discussions and negotiations. This method is important so that there is no hidden agenda and both parties are aware of their responsibilities. The availability of handbooks for units 1-6 (i.e., the curriculum) as well as evaluation (which takes several forms and is an ongoing process) form a critical part of the programme.

The overall impression is that of a dynamic, constantly evolving curriculum to which both students and teachers contribute. Students working in pairs or groups out of the classroom setting is also common.

Recommendations

- It is timely for the Faculty of Medicine at the University of Hong Kong to introduce PBL as a *mandatory component* throughout the entire medical curriculum at the earliest possible time. The process has already started in several Departments and the efforts need to be coordinated and integrated. Workshops on PBL and tutor training courses should also be initiated.

- It would be extremely useful for members of the Faculty of Medicine (preclinical and clinical) to visit McMaster (or equivalent institutions where PBL is established) to experience at first hand the power of the learning method as well as to dispel some misunderstandings about methods associated with PBL, i.e., the need for extremely gifted students, students not knowing what to learn, fear that students will not learn the 'basic' facts, etc.
- If any programme is to be introduced, adequate physical facilities for learning and tutorial groups must be established. It is recommended that specific rooms are set aside for small group teaching so students are not forced to be accommodated in rooms which were not designed for PBL and which do not engender a good learning atmosphere. An open, quiet space allows for good interaction amongst students and tutors. We already have good computer facilities but a greater emphasis should be made for the introduction of computers and information technology into the curriculum so that students learn to gather information from other sources besides textbooks.

PBL and Medical Education in SIU: A Radical Reform

Following recommendations from the teaching consultant from McMaster University that medical students of the University of Hong Kong should be able to adapt to the PBL approach, H.P. Sheng became interested in visiting other medical schools to gather information on how they solve the problems and difficulties of changing from a traditional to a PBL curriculum. The following is a summary of Sheng's impressions of the PBL curriculum used by Southern Illinois University (SIU), School of Medicine, Springfield, Illinois as well as Sheng's views of how well the PBL approach can be adapted for use for teaching of Physiology.

H.P. Sheng was very impressed with both the PBL curriculum and the faculty involved in that curriculum at SIU Medical School. The Medical School essentially has two streams of education methods in their first two years of basic science courses: traditional and PBL. The clinical departments still use the traditional method, but Sheng understands that efforts are being made to convert to PBL soon. Sheng's two day visit was with Dr. Howard S. Barrows, Professor and Chair of Department of Medical Education. Dr. Barrows has been working towards establishing a successful PBL programme at the SIU Medical School for about 12 years since he left McMaster and joined SIU. Their PBL programme has been in place for about six to eight years.

The success of the PBL curriculum at SIU is due to many factors:

Selection of Students Who are Mature and Self-Motivated

H.P. Sheng participated in both a workshop and a tutorial session. The students with whom Sheng talked are very enthusiastic about the programme and highly recommended it. These students are in the programme by choice and were selected after an interview. Approximately one-third of the students are in the PBL curriculum while the remainder either opted for the traditional stream or were not accepted into the PBL programme. In the tutorial session, the group of students (six per group) interacted very well and seemed to have done their assignments prior to the tutorial so that much information was given and exchanged during the session.

Resource Allocation for PBL Model

Available space and experienced tutors are crucial for a successful PBL programme. Staff and students meet twice a week for tutorials and once a week for an examination of 'standardized' patients. Since only 24 students per year were admitted into the PBL programme at the SIU Medical School, only four tutorial groups need to be scheduled. Each group is assigned to a particular tutorial room for each PBL unit (module) so that facts, ideas and learning issues generated during the tutorials remained on the board to provide references for discussions during the tutorials.

Institutional Commitment

Staff involved in the PBL curriculum are constantly undergoing assessment and improvement of their programme. All tutors involved in a particular unit meet once a week to discuss the aim of that module. The 10 units that cover the whole basic sciences course were put together after input from unit consultants and a unit coordinator.

After an intensive two day visit to the SIU Medical School and a review of the situation at the University of Hong Kong, Sheng's recommended that the PBL approach can be introduced into the Physiology Department to the extent that the above requirements will be met. Objectives and basic principles relating to the physiological control of various systems can be given in large-group, teacher-centred lectures with some PBL components. Small group tutorials, based on the student-centred PBL approach can be introduced in parallel with the large-group sessions. The PBL sessions in which the students are expected to participate will fully cover pathophysiology, community health, behavioural sciences, clinical applications, etc., based on the fundamental principles they have learned.

PBL and Teaching of Life Sciences: A Broader Perspective

T.M. Wong visited the Faculty of Health Sciences of McMaster University to observe small group tutorials using the PBL approach. Wong attended two tutorial sessions: one for first year medical students and the other for second year Biology students as well as a practical session for the Biology students. In addition, Wong observed how assessment of medical students was conducted. Unfortunately, due to the fact that the presence of a stranger may have intimidated the student, sitting in on the assessment was not possible. The following discussion will concentrate on Wong's observations of the small group tutorials of medical and science students.

PBL is an Effective Learning Concept Applicable to Medicine as Well as Science

Each tutorial group comprised 6 students with one tutor. The students collectively decided on the objectives which derived from the issues brainstormed in the previous session. For the first 90 minutes, the students reported to the group about what they had learned. This stage involved active exchange of views among the students. In the second half of the tutorial, they set the individual and group objectives for the next tutorial via extensive discussion and debate. At the end, they evaluated the individual and group performance in the tutorial. The whole tutorial lasted 3 hours. The medical students, who were all university graduates, spoke with confidence and authority. They were able to clarify questions raised among themselves without having to consult the tutor. In fact, they decided almost everything with occasional input from the tutor. The tutor played the role of a facilitator. On the other hand, the second year Biology students, who were of about the same age as first year medical students at the University of Hong Kong, seemed to need more guidance from the tutor. (Provision of more guidance to the science students was later learned to be partly due to the different policy in the Faculty of Science and the style of the tutor).

PBL is Intellectually Challenging to Student Learning

At the end of each tutorial, Wong asked the students a few questions. Both groups stated that they enjoyed small group tutorials with the PBL approach. They were also asked if they found it difficult to study mainly on their own, to which they responded that it depended on the problem. One worry expressed by a medical student was that he was not sure how much he was expected to know. This question seemed to be a common anxiety for first-year medical students during the first four to five weeks in the medical programme. These medical students stated that they spent eight to nine hours to prepare for the three hour tutorial which Wong attended. The science students were asked if they preferred large group lectures for difficult topics. The answer was 'no!' They

preferred learning by themselves first, then discussing and clarifying in small groups. They showed a sense of pride in such a learning environment.

How Can Small Group PBL Fit in the Teaching/Learning Culture at the University of Hong Kong?

There are three main differences between the PBL approach employed at McMaster University and the conventional teaching at the University of Hong Kong. First, in the former system students themselves initiate the study protocol, facilitated but not dictated by the tutor (**student-centred learning**), while students at the University of Hong Kong are provided with all the information (lectures, handouts, notes, demonstrations) by teachers (**teacher-centred learning**). Second, clinically-oriented problems are used as means to raise all aspects of issues related to the problem in the former system (**integrative learning**), while information is given to students systematically by disciplinary areas, mainly via lectures in our system (**doctrinal learning**). Third, small group tutorials with free exchange of information are used in the former (**group-learning**), while didactic lectures to large groups of students are the main means of information transfer in our system (**group-teaching**). One obvious advantage of the small group PBL tutorials over conventional didactic lectures is that students learn to acquire knowledge on their own early on. Time is more effectively used, as students do not have to spend hours in classrooms listening to lectures, from which they gather what they are supposed to learn or memorize. Another advantage of PBL is that students are exposed at an early stage to a learning environment conducive to their future professional environment. In small group discussions, students also learn to communicate. A perceived drawback of PBL is that the students who are used to surface-learning based on the conventional systematic didactic approach may not survive the PBL process. Furthermore, the students may not have sufficient guidance unless they seek it actively and if the tutor fails to identify the problem(s) in the tutorial group.

Based on Wong's experience with students at the University of Hong Kong, who are the cream of the high school graduates, Wong believes they are capable of using small group PBL tutorials if they are given proper guidance. This view is supported by the success of the second year science students in McMaster University, who are of the same age and maturity as first year medical students at the University of Hong Kong and who are not specially selected for their suitability for PBL in the admission process (as in the MD admission process). Some University of Hong Kong students may need to improve their English and communication skills in order to obtain the maximum benefits of PBL. One resource implication of small group teaching is a substantial increase in teaching load. Compared with McMaster University, which has 300 medical students over a three year programme, the University of Hong Kong has at least 850 medical students over a five year programme. The Medical Faculty needs the support of the University in allocating adequate resources in order to support a successful reform. Of crucial importance is training and incentives for teachers. Training is essential for teachers at the University of Hong Kong to rapidly become effective in the small group setting. Some form of incentive is also necessary in order to encourage teachers to embrace improved teaching methods.

In keeping with the change of medical education in many medical schools in North America, Britain, Europe and Australia, the Medical Faculty of the University of Hong Kong has taken its first step towards innovative reform of the medical curriculum as traditional teaching is no longer able to cope with the rapid advancements in medical knowledge. The Medical Faculty should make use of the experience of other universities using the PBL approach, taking into account the resources and culture of the Hong Kong educational system to strengthen and modernize the medical education programme at the University of Hong Kong.

PBL and Medical Curriculum at HKU: A Hope with Risks

Following the recommendations made by the teaching consultant and visits to McMaster University, further actions have been taken to initiate and participate in the following activities in the Faculty of Medicine:

Presentation of Seminars to the Department of Pathology

In January 1996, L.C. Chan presented a seminar entitled 'Teaching resolutions for 1996' which outlined the objectives of effective teaching, including the importance of aligning teaching objectives, teaching/learning activities and assessment. A brief review using case situations for teaching Pathology was also included. Chan recommended that seminars related to teaching/ learning/curriculum be held on a regular basis in the Department of Pathology to help disseminate information and provide a forum for discussion among the staff. In June 1996, J.M. Nicholls presented a seminar entitled 'McMaster University — Myths and Myhttakes' which highlighted the type of laboratory resources and learning skills required for a programme like that at McMaster. In April, L.C. Chan was also invited by the Department of Paediatrics at the University of Hong Kong to brief them on aspects of learning through the use of case situations. One afternoon was specially dedicated to discussion of the Undergraduate Paediatric curriculum.

Development of PBL in the Department of Pathology

Through informal discussion with colleagues as well as through a formal meeting of the Curriculum Committee of the Department, there was overall support for the proposal that PBL be introduced to the current third year medical students through the use of clinical case situations in Pathology.

A group comprising J.M. Nicholls, L.C. Chan and Professor Masarei (representing the discipline of Clinical Biochemistry in the department) was formed to propose three clinical problems which would be suitable for PBL. A series of three meetings was organised for the teachers and honorary teachers of the department. The following objectives were achieved:

- Identification of staff willing to take part in PBL: This included all the teachers and two honorary teachers.
- Discussion of the cases: The cases were modified based on feedback from the teaching staff. In addition, resources for learning were identified for one of the cases.
- Discussion of assessment : There was support for a formative type of assessment.

The meetings also provided opportunity for the staff to present issues and questions related to PBL in general. Guides to running small group teaching sessions were provided and both J.M. Nicholls and L.C. Chan expressed interest in running a tutor training session for staff. The PBL sessions are scheduled to be held in November, 1996, and owing to the restricted number of suitable rooms, each tutor will be grouped with ten students.

Participation in the Review of the Undergraduate Curriculum for the Faculty of Medicine

Both J.M. Nicholls and L.C. Chan are identified in the faculty for their interest in and commitment to enhancing the medical curriculum through small group teaching using PBL (and, in the case of J.M. Nicholls, the use of CALS as a mode of teaching). As a result, L.C. Chan has been invited by Professor S.P. Chow, Dean of the Faculty of Medicine, to be an *ad hoc* member of an Interim Core Group of the Undergraduate Curriculum Reform Group of the Faculty (Chairman: Professor A. Dixon), which aims to propose a new curriculum for the September 1997 intake of medical stu-

dents. The curriculum will be based on the recommendations of the General Medical Council's position paper entitled 'Tomorrow's Doctors', which highly recommends the effective use of student-centred, small group PBL to replace the traditional teacher-centred, large-class didactic lectures. Several meetings have been held since April, 1996 to help formulate an undergraduate programme which will meet the needs of Hong Kong. Various subgroups examining specific areas of the programme have been identified and one is to design a Foundation Course for students in the first 12 weeks of the medical programme. L.C. Chan and Professor Y.L. Lau, Associate Clinical Dean, have been asked to coordinate the Foundation Course. Meetings with the preclinical departments of Anatomy, Biochemistry and Physiology were initiated at the beginning of the academic year to seek advice and input into the planning of the course.

J.M. Nicholls' role in the Curriculum Reform Group is to coordinate the integration of computers into the learning curriculum and ensure that future doctors will be able to use this medium to enhance their self-learning and knowledge access. As a result of the visit to McMaster University, Nicholls is fully aware of the importance that physical resources play in the implementation of the new curriculum and has been working on the physical requirements (rooms, computers, resource areas) needed to implement such a programme.

There is no doubt that the progress and involvement in enhancing Pathology teaching was initiated by our specific roles as coordinators for Pathology in the ALP. Through contact with and support from other members of the academic community, in particular Professors. C.Y. Kwan (Physiology), A. Dixon (General Practice, Medicine) and Mr. J. Marsh (Centre for Advanced University Teaching), we have been inspired and helped to focus on both the specific and general issues related to improving the medical curriculum.

Conclusions and Future Perspectives

PBL is a form of action learning, and represents a process of active, adult and professional learning. PBL is applicable to a wide spectrum of professional training inside and outside the medicare profession. Postgraduate research education is also a form of PBL, in which the research topic is the 'problem' and it requires team-work as well as self-directed learning. The postgraduate student cannot rely totally on the supervisor for information. He or she needs to learn to search for information and learn the techniques needed for the research project. The postgraduate student also needs to formulate and test hypotheses with learned or innovative experimental designs. He or she needs to develop the appraisal skills in data interpretation and the communication skills in presenting ideas and observations in the form of seminars or written publications. The ALP team feels that the PBL approach in medical education not only fosters mature, caring and competent physicians with leadership qualities, but also fosters potential medical researchers with a deep understanding of clinical problems. While there are multiple benefits, there are also price tags on the practice of PBL in any educational system. PBL is not merely a teaching technique, but is also a profound educational concept with layers of complexity. Effective and successful transition from a conventional medical educational system to a PBL-oriented system cannot materialize overnight and may take years. The practice of PBL alone will not achieve the intended purpose of educational reform without securing other factors, such as strong institutional commitment, an appropriate management structure, accessory supporting units, faculty training and development, experienced leadership and effective resource redistribution. By analogy, most physicians understand that the management of hypertension will not be effective if the physician fails to consider the associated risk factors, such as old age, sex, obesity, high fat and/or salt intake, smoking, stress, lack of exercise, other medication, etc. This ALP team has experienced only the basics of the PBL concept. Future studies should be directed to understanding and managing the risk factors which may undermine the effectiveness of PBL in the reform of medical education in Hong Kong.

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