

Monitoring the Outcome of Problem-based Learning in Medical Education

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After more than 30 years of experimenting with problem-based learning (PBL) in medical education, the question is still being asked whether PBL is better than the traditional approach in producing competent physicians. Several reviews were published in 1993, and then in 2000, some of which challenged the effectiveness and underlying cognitive processing associated with PBL. Others had emphasized the high faculty cost of using PBL and cautioned those who are thinking of using PBL, pointing out the apparent lack of visible difference in the types of graduates from the two streams of teaching and learning. In 1990, a group of medical educators from North America had produced a list of areas where they hypothesized that there would be differences between the graduates from a PBL curriculum as compared with those from a conventional curriculum. In this review, I will use the areas as projected by them as the basis, by incorporating results from some of the recent studies not discussed by the reviews from 1993 and 2000. I conclude that differences were indeed found among the graduates from the PBL versus conventional curriculum, and that PBL is still the best method we know to date to train competent physicians.

**Key words: problem-based learning, medical education
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INTRODUCTION

Following the publication of the Flexner's reports on medical education in North America^[1] and Europe^[2], major changes in medical education had taken place where the importance of basic sciences as an integral part of the medical curriculum was a main focus of the education reform. Subsequently, it was recognized by some educators that the traditional didactic method of teaching where students

take a passive role in learning, is not ideal in the training of physicians. The use of an integrated approach in medical education during the initial two years of study was introduced by Case Western Reserve University School of Medicine in the United States in the 1950s^[3], but the move towards using a problem-based learning (PBL) approach in medical education was pioneered at McMaster University in Hamilton, Canada^[4], where an interdisciplinary self-directed learning based on small group tutorials was introduced. Following the publication of the GPEP

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report in 1984 by the Association of American Medical College's Panel on the General Professional Education of the Physicians and College Preparation for Medicine^[5],* and a position paper on undergraduate medical education issued by the British General Medical Council entitled "Tomorrow's Doctors" in 1993/1994, interest in changing from a traditional teaching method to PBL in medical education has become a world-wide phenomenon. It has been estimated that out of an approximately 1400 medical school world-wide, a figure provided by the World Health Organization, there are around 150 which are using a PBL approach (H. Schmidt, personal communication). The number is still on the rise, based on the attendance at various international conferences and workshops on PBL, with an overwhelming majority of attendees showing keen interest in using or switching from a traditional curriculum to PBL curriculum. The percentage of medical schools in the United States which reported self-instruction (a surrogate of PBL) as an innovation has increased from 79% in 1994-95 to 94% in 1998-99 (quoted from Albanese^[6]). The degree by which PBL is used in the medical curriculum, however, varies from one school to another, ranging from a total PBL approach, such as the one used at McMaster University, to a so-called hybrid approach, i.e. using a combination of traditional didactic teaching with PBL, and schools with parallel streams, running PBL stream along side traditional stream. The question which is often asked, is "does the PBL approach really produce the kinds of physicians which some educators had expected?"

In 1993, three review articles had appeared which analysed the effectiveness of PBL in medical education. Two were meta-analyses based on international literature from 1970-1992 comparing conventional education with PBL, with somewhat opposing results, where one showed mostly positive results in favour of PBL^[7], and the other had raised several concerns about PBL^[8]. The third review concluded that graduates of PBL curriculum are dif-

ficult to distinguish from those of traditional schools, that PBL can be stressful to both students and faculty, and that the curriculum may be unreasonably costly^[9]. In 2000, Colliver reviewed the medical education literature from 1992-1998, and concluded that there was no convincing evidence that PBL improves knowledge base and clinical performance, and that the theory regarding PBL is weak and basic research on PBL is contrived and ad hoc, using manipulations that seem to ensure the expected results regardless of the theory^[10]. These views were challenged by Albanese concerning their interpretation of the results regarding effects^[6], and by Norman and Schmidt^[11], who stated that basic cognitive research is not contrived and irrelevant, and that curriculum level interventions using simple experimental designs such as randomized controlled trials are doomed to fail.

As a result of a conference sponsored by the Macy Foundation in 1989, Freidman et al. had produced a list of 26 items which they hypothesized that there would be a difference between traditional and PBL curriculum, and 5 areas where they did not expect to find a difference^[12]. In this review, I will use the broad areas as suggested by them as a focus, to discuss some of the results from the outcome studies in relation to the use of PBL in medical education, by incorporating some of the studies which were not discussed in the reviews published in 1993 and 2000. Because research results or information in some of the areas hypothesized by them is not available, only areas where there are sufficient or good data will be discussed.

AREAS WHERE PBL CURRICULUM IS BETTER THAN TRADITIONAL CURRICULA

Psychosocial and Interpersonal Skills

a. Interest in Primary Care

The perception that graduates from PBL schoo-

ls are more likely to choose primary care than other specialties in comparison with graduates from conventional programs, is not supported by the results of several studies. A study of the McMaster graduates reported in 1987^[13] found that compared with graduates of other schools, McMaster graduates were equally likely to have chosen primary care as their medical field. Of those in primary care, a higher proportion of McMaster graduates than other graduates held certification in family medicine. One study actually found that the proportion of physicians practising primary care was greater among graduates from a conventional school (University of Ottawa, 56.4%) than those from a PBL school (McMaster University, 45.5%)^[14]. At the University of New Mexico where there are two parallel curricular tracks, a comparison of graduates from conventional track and the Primary Care Curriculum (PCC) track which uses PBL, again showed similar results as those from McMaster, with equal percentage of them who chose primary care careers, notably in family practice, as compared with other specialties^[15]. However, they found that PCC graduates were more likely to practice in medically underserved areas, publicly funded health care setting, and care for non-paying patients than were the conventional-track graduates. It appears that if one wants to design a curriculum to channel more physicians to rural or medically underserved regions, an exposure of students to these communities during their training would be advantageous.

b. Sensitivity to Individual Patient Needs and Awareness of and Ability to use Community Resources

A survey of McMaster graduates showed that in comparison with their peers, most of them felt that they felt better prepared than fellow trainees in "methods of dealing with social and emotional problems of patients", "behavioural science information", "follow-up medical care", "ambulatory patient care", "in-patient care", and "preventive care"^[16]. These perceptions were supported by the ratings from their

immediate supervisors, which showed a more positive rating than the graduates' self ratings. Studies of New Mexico graduates also showed that students from PCC track were better prepared than students from the conventional track in the areas of patient care, patient education, preventive care, and doctor-patient relationship^[15]. The New Mexico study found no evidence to support the hypothesis that PCC graduates would use a wider range of community resources. This was based on the assumption that early extended, rural primary care experiences in the PCC track, and the increased programmatic attention to the use of resource networks in community setting, may predispose them to use a wider range of community resources^[15].

c. Ability to Work Efficiently and Effectively in a Diverse Team

There are at least two studies which showed that graduates from PBL curricula reported that they possess better cooperation and interpersonal skills, are good at helping colleagues^[17], and have better teamwork ability^[15]. This is probably not surprising, considering the fact that these students have learned to study together in small groups, where co-operation among group members is essential to create an effective learning environment for the group members.

d. Communication Skills

Based on ratings from residency supervisors, nurses and self-evaluations, a New Mexico study found that residents from the PBL track always rated themselves higher in their ability to communicate effectively with patients than those from conventional track^[18]. Study of McMaster graduates also showed that McMaster graduates were more likely to spend more time per patient and attending more to the psychological component of patients' problems^[19].

CONTINUING EDUCATION

One of the perceived strength of PBL curriculum is that graduates from such a curriculum are

more likely than those from conventional curriculum to keep up to date in both traditional and innovative ways, and modify their practice activities in accord with changing biomedical knowledge, and habitually filling perceived gaps in medical knowledge. Unfortunately, there is no clear evidence to date to either support or refute these claims. A comparison of McMaster graduates with those from the University of Ottawa, which had a more traditional curriculum, was conducted, based on their participation in continuing medical education (CME) activities^[14].

It found no significant difference between the rates of participation by the two groups in a variety of CME activities: reading, using audiovisual materials, teaching, attending conferences, and participating in CME credit courses. Specialists from both schools spent more time attending hospital rounds and national and international conferences than did their family practitioner classmates.

PROFESSIONAL SATISFACTION

Level of Student and Faculty Satisfaction with Their Circumstances in Medical School

This is an area where different surveys have consistently showed that both students and faculty are quite satisfied with the PBL curriculum^[7,8,20,19].

A survey of McMaster graduates showed that a majority of graduates would return to a problem-based medical curriculum: 58 percent to an unaltered curriculum, 3 percent to one altered slightly, and 8 percent to one spread over four years^[20]. Of those that would not return, most chose a somewhat more structured curriculum, while very few chose traditional curricula^[20].

PRACTICE BEHAVIOUR

a. Referral Pattern

Study from New Mexico showed that their results did not support the hypothesis that more PCC than conventional-track graduates would consider

patient needs when making referrals^[15]. This assumption was based on the hypothesis that as a result of learning in the context of outpatient problems and frequent interaction with patients, the PCC graduates would have an enhanced perception of patient needs that would be expressed in their patient-referral patterns. A survey of McMaster graduates also showed that they did not differ from graduates of conventional schools in their use of laboratory tests, diagnostic procedures or consultations^[19].

b. Extent to Which Graduates Conduct Research and Teaching

An analysis of the survey conducted by the Canadian Medical Association on the practice patterns of Canadian medical graduates showed that more McMaster graduates received salaried income from universities than graduates from conventional curriculum^[21]. The McMaster group spent more time on teaching, research and administrative activities.

Among all physicians who reported teaching, McMaster graduates spent more time in educational activities than did respondents from the comparison groups^[21]. It was suggested that one of the reasons for the high production of physicians pursuing academic careers, may be due to the fact that students who are interested in education are more likely to choose an educationally innovative school and continue on to careers in academic medicine^[21]. Results from New Mexico study also showed that of those who were involved in teaching, PCC graduates indicated slightly more hours spent in teaching activities than those from the conventional track^[15].

c. Extent to which Graduates Participate in Community Activities

A survey of New Mexico graduates showed that of those who were involved in community activities, the PCC graduates tended to spend more time in these activities than the conventional-track graduates^[15]. The same study also showed that proportionately fewer of the PCC graduates participated in hospital organizations than did the conventional-track graduates.

EDUCATIONAL ACHIEVEMENT AND COGNITIVE DEVELOPMENT

a. Scores on Board Examinations

This is an area where significant discussion and arguments existed among different studies and reviews. One review cited studies where PBL students scored lower on basic sciences examinations and viewed themselves as less well prepared in the basic sciences than were their conventionally trained counterparts^[8]. Another review using similar approach and data and published in the same year pointed out that even though traditional students performed significantly better than their PBL counterparts on the National Board of Medical Examiners Part I examination, the data, however, displayed significant overall heterogeneity and significant differences among programs, which casts doubt on the generality of the findings across programs^[7]. A recent study showed that, over a seven-year period, graduates from a PBL and traditional lecture-based curricula performed equally well in the United States Medical Licensing Examinations Step 1 and Step 2^[22]. These results give an indication of the long-term effectiveness of PBL with respect to basic and clinical science knowledge acquisition^[22]. The experience at McMaster showed a lack of association between the curriculum and the passing rate on the licensing examination^[23], as shown by the effects of introducing a formative evaluation exercise in the curriculum^[24].

b. Cognitive Development

This is an area where there are major disagreements among different educators and reviews. Albanese and Mitchell in their review pointed out that PBL students exhibited cognitive-processing weakness, using backward reasoning as a search-driven process typical of novices, in contrast with forward reasoning, which would seem to be consistent with the pattern recognition or illness-script conceptualization of expert problem-solving process^[8]. Col-

liver also pointed out that the theory behind PBL is weak, and that its theoretical concepts are imprecise, lacking explicit descriptions of their inter-relationships and of their relationships with observables, such as interventions and outcomes^[10]. Albanese concurred with Colliver that contextual learning theory generally associated with PBL is weak, but offered four other theories that he thought offered promise for better explanation and prediction of what elements of PBL are effective^[6]. These include information processing theory, cooperative learning, self-determination theory, and control theory. Norman and Schmidt, on the other hand, argued that basic cognitive research is not contrived and irrelevant, because the interventions are precise, the outcomes are highly relevant, and that the effects are non-trivial^[11]. They also discussed their findings which showed that backward reasoning may not be a bad thing, as the overall accuracy of arriving at a correct electro-cardiogram (ECG) diagnosis was 42% in the group which used forward reasoning, in contrast with 59% in the backward reasoning group^[11]. Schmidt and Moust discussed various researches which showed PBL affect cognitive processing in several ways^[25]. These studies showed that problem analysis in a small group has a strong activating effect on prior knowledge. This facilitates the students to understand and remember new information, even if that prior knowledge is only to a small extent relevant to understanding the problem. They also noted that PBL induces students to retain knowledge much longer than students under conventional teaching conditions, and that PBL motivate intrinsic learning in the students^[25]. Overall, I tend to agree with Norman and Schmidt that there are sufficient research to support the basic premises of PBL in terms of cognitive processing, and that education needs more theory-based research conducted in relatively controlled settings, if real advances in educational practice are to result^[11].

AREAS WHERE NO DIFFERENCES ARE EXPECTED

Several areas where no difference between graduates of traditional curricula and PBL and/or community-oriented curricula were listed by Friedman et al. [12]. However, as can be seen below, recent evidence suggests that there are actually some differences among the graduates in these areas.

a. Passing Rates on Licensure and Certificate Examinations

Overall, there is no evidence to support that there is a correlation between the types of curricula and passing rates on licensure examinations. Depending on the type of analyses and the type of examinations, differences in the passing rate of licensing examination between graduates of traditional and PBL curricula were found in some studies and not in others [8,26,7]. Graduates from McMaster University also showed some fluctuations in their licensure passing rate, but overall passing rate is at the national average [21]. McMaster graduates have consistently obtained higher rate of first-choice placements in their residency placements, in comparison with the Canadian average, and a higher rate of certification [21]. As discussed above, the ability to pass licensure examination is not a reflection of the types of curricula, but more related to the preparedness of the graduates to adjust to the examination format they are subjected to.

b. Likelihood, of Making a Major Clinical Mistake, in Practice

There is no good data to support or refute this statement at the moment. It would have been interesting to do a correlative study between the types of curricula, and the number of disciplinary actions from the governing bodies on the physicians, but it would be difficult to do, in view of the fact that many schools have converted their curricula to PBL in recent time, especially in North America. Schmidt et al. [27] had presented 30 case histories to students

from the three Dutch medical schools, one with PBL curriculum, one with an integrative curriculum, and one with a traditional curriculum, and asked them to provide differential diagnosis. Students in their second, third, or fourth (preclinical) or fifth or sixth (clinical) years of their studies were included. They found that overall, students trained within the PBL framework and the students trained within the integrated curriculum made more accurate diagnoses than the students trained within the conventional curriculum. They also noted that the difference became apparent only in the clerkship years. The reason for this was unclear, but they had suggested this difference appeared only when students began to deal with real patients in the academic hospital or outside.

In a Physician Review Program (PREP) conducted in Ontario, Canada, under the auspices of the College of Physicians and Surgeons of Ontario, a competency assessment on knowledge, skills and safety to practice was given to primary care physicians. The results from 1994 showed that seriously deficient and unsafe physicians had major problems in the areas of record keeping, management, history taking, physical examination, problem solving, knowledge, interviewing skills, and communication skills [28]. The training background of these physicians was not given. It is relevant to note that in a survey of the PBL graduates from Maastricht, the Netherlands, areas of competency rated highly by these graduates included: problem-solving skills, interpersonal skills, paper presentation skills, ability to work independently, and planning skills. These skills may be beneficial in reducing the incidence or the degree of difficulties physicians may experience in their professional life.

Studies have shown that knowledge and skills decline overtime, probably due to failure to acquire new knowledge rather than forgetting knowledge acquired during training [19]. In this regard, it is interesting to note that graduates of a PBL curriculum were more up to date in knowledge in the management of a disease (hypertension) than graduates of a

traditional curriculum ^[29]. These results provide some evidence that PBL curriculum may influence some practice patterns of the physicians.

c. Education Costs per Student

Friedman et al. had suggested that in the steady state after start-up costs of innovative programs have attenuated, there should not be a difference between PBL and traditional curricula in terms of educational costs per student ^[12]. In the review by Albanese and Mitchell ^[8], they had noted that PBL costs in terms of faculty efforts appear to be similar to those of the conventional curriculum for class sizes of 40 or fewer and perhaps for those up to 100. For class sizes exceeding 100, they cautioned that there are fairly serious concerns about the economic viability of PBL, simply because more faculty time commitment is needed for PBL than conventional lecture-based curriculum, the latter is not affected by class size. I agree with their projection, as more tutors are needed as class size increases, in order to maintain a small tutorial group size. However, as pointed out by Kassebaum ^[3], medical school faculties now devote only 15% of their time, on average, to teaching medical students, and that the will - if not the courage - to raise that investment is a precondition to more pervasive change.

d. Cost-Efficiency of Graduates as Practitioners

A study of the practice pattern of general practitioners or family physicians showed that McMaster graduates did not differ from graduates of other medical schools in their use of laboratory tests, diagnostic procedures, or consultations ^[19]. They were, however, more likely to spend more time per patient and attend more to the psychological component of patients' problems. The study of New Mexico graduates showed that PBL graduates were more aware of the health care costs than graduates from the conventional track, and this may be related to the curricular emphasis on cost for laboratory tests in individual case problems and total costs for individual patient work-ups during periodic student evaluations ^[18].

Whether this would translate to a difference in their

practice pattern is not clear.

CONCLUSIONS

After more than 30 years of experimenting with PBL in medical education, there are still questions regarding its usefulness or effectiveness. Most educators do not expect a major difference in knowledge and clinical skills between graduates of PBL and traditional curricula at the time of their graduation.

This is probably because medical students are generally highly motivated students. In order to meet their licensing and professional standards, they will find ways of making up for any deficiencies they may have encountered during their medical training.

Furthermore, there is no good evidence to support the premise that PBL promotes life-long learning. Therefore, the question still remains: should PBL be used in medical education? My answer is yes, based on the following reasons.

Most surveys consistently showed a high level of satisfaction from the faculty and students in terms of their PBL experience, as noted above. This is not surprising, because in a PBL curriculum, students are active learners in contrast with passive learning in a traditional didactic environment, where learning is controlled by the instructors. As noted by Albanese ^[6], even if knowledge acquisition and clinical skills are not improved by PBL, enhancing the work environment for students and faculty is a worthwhile goal in itself.

There is no question in my mind that PBL when used in the context of McMaster approach facilitates the development of interpersonal skills, group skills and communication skills in our students. These are essential elements of a good physician.

Considering the explosive growth of medical knowledge in recent times, it is desirable that we provide our students with adequate self-directed tools during their medical training, which will help them to become life-long learners. In the absence of a better alternative, I think PBL still offers a lot of

advantages over conventional curriculum in the training of physicians, and therefore remains the best method we know to train competent physicians.

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