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Review

Problem-based learning★

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Problem-based learning has been used in medical school in a number of different countries around the world for over 50 years, with both undergraduate and graduate students. Instead of the traditional lectures, laboratory practical classes and tutorial system of education, students in small groups are presented with a problem that they must try to solve. They are assisted by a 'facilitator' who helps them formulate the problem and generally advises them but does not supply information. The students have to decide what information they need to solve the problem, find it and communicate it to the others in the group. At this stage a solution may be apparent, but several more group discussions to reformulate the problem followed by re-iterations of the information seeking process may be needed before a solution can be found. The theory is that because information is sought and presented in a relevant context, it is valued and is more likely to be remembered. At the end of the session student reflect on how they performed. Problem-based learning has been criticised from a number of points of view, especially that it does not present a coherent curriculum, the curriculum is not necessarily 'covered', and that in many medical schools the implementation has been less than optimal.

For over 50 years problem-based learning (PBL) has been a method of education, mainly in medical schools in Canada and U.S.A (Boud & Feletti, 1997). Instead of following a set curriculum with lectures and other classes, students are presented with a problem and work in small groups with a 'facilitator'. They try to formulate the problem in terms they can understand, decide what information they need to solve it, find the infor-

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mation, and re-iterate the process until the problem is solved. At the end they reflect on what they did and on how successful they were. This seems to turn the traditional process of education on its head. Why was it instituted and what are the advantages and disadvantages?

THE PROBLEM OF TOO MUCH KNOWLEDGE

From almost the turn of the last century various authorities and eminent medical people started to recognise that with the growth of information about medical topics, medical students were being overloaded with facts they were required to remember (Osler, 1913). As the century progressed this problem became increasingly acute with the exponential growth of knowledge in medicine and in bioscience generally. It had to be admitted that no one person could remember it all, and that hard-pressed students only remembered things for the examination, but soon afterwards forgot them. It was realised that not only was there too much knowledge to be remembered but also that people only remember information when they need it and use it. Furthermore, at the start of a medical career, the information that a student remembers (inevitable a fraction of the whole) may not be the right information to solve future problems and also such information may not even have been discovered at the time of graduation (Hughes & Wood, 2003). The question was what to do about this? A possible solution was to develop in students the ability to find and use information when required for solving a problem, not to remember.

WHAT IS 'LEARNING'?

To the average person 'learning' means 'remembering', committing to memory. One might remember a telephone number, the molecular weight of *Tris*, a poem, etc, and such memorisation involves little or no processing of the information. Students use this sort of memorisation in order to pass examinations, assuming that the examination requires straightforward recall of information. This is sometimes called 'shallow' learning, to contrast it with 'deep' learning, where the information is processed. 'Processing' means taking knew knowledge, understanding it and checking that it fits in with one's existing knowledge, and incorporating it into one's present framework of knowledge. Sometimes this is said to be a process of 'digestion'. Such knowledge is much more likely to be remembered accurately and for a considerable time, and much more likely to be of use in solving problems, because it is properly understood. We can encourage students to do 'deep' learning if the examination or assessment tests understanding and ability to use information rather than simply recall. Actually students learn strategically. If the assessment asks for recall then that is what we get: if the assessment requires using information constructively then we encourage deep learning. One of the problems with assessment systems that simply ask for recall is not only that students do not develop an understanding, but also that there is 'delayed learning' — until they have done a certain amount of digesting their understanding cannot develop properly.

WHAT IS PROBLEM-BASED LEARNING?

In problem-based learning a small group of students (usually 6–8) is presented with a problem (Smith *et al.*, 1995). In a medical course, the problem will be a medical one, possibly some information from which the group is required to reach a diagnosis. The group is 'supervised' by a member of staff, referred to as the 'facilitator' whose function is to guide and advise the group and keep them on the right track. The group might meet on a

Monday and spend several hours discussing the problem, trying to understand it and then re-formulating it in such a way that they can see their way to solving it. Some of the members of the group may have knowledge that can help in formulating or partially solving the problem. At the end of this first session the group decided what information they need to try to solve the problem and they divide the tasks among the members of the group. They then disperse and individually seek information which they will bring back to the group when it convenes again, for example of the following Wednesday. The individuals bringing back the information will be expected to have 'processed' the information such that they can understand it and explain it to the rest of the members. After the presentations have taken place the group discusses whether they are in a position to try to solve the problem or whether they need further information at this stage. Perhaps a reformulation of the problem takes place and there will then be a re-iteration of the process of finding and bringing back information to the group. The group may then meet again on the Friday of the same week and try to reach a conclusion. Other meetings may have taken place during the week to clarify the group's aims. A solution may be reached, or the group may perceive that there is more than one solution, or they may be unable to reach a solution with the information that they have. In any case, with the help of they facilitator they reflect on what they did during the week, how they might be more efficient the next time, what things helped and what were a waste of time, and so on. Then the next week a new problem will be presented. Clearly by selecting appropriate problems, those in charge of the curriculum can to a large extent control what topics are covered.

This is in outline how PBL can work (Fig. 1). However, there are many variations possible rather than "full-blown" PBL. Some schools combine PBL sessions with lectures (and this may be important with undergraduates when

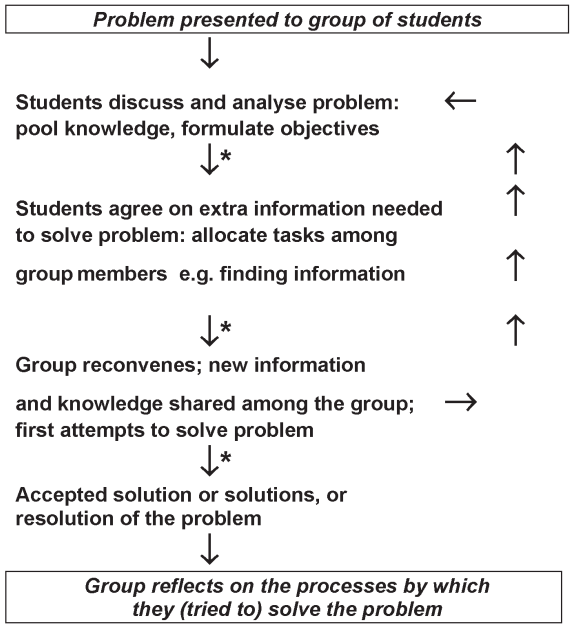

Figure 1. Outline of the sequence of events in problem-based learning.

The arrows represent re-iterations and the * indicates places where the facilitator may offer help, guidance and advice.

the students' level of knowledge and understanding may be quite low) and other classes (Burdett, 1996), and some schools use much shorter PBL sessions, occupying the place where formerly lab classes may have been held.

WHAT ARE THE ADVANTAGES AND DISADVANTAGES OF PBL?

PBL embraces the principles of good learning and teaching. It is student-directed (which encourages self-sufficiency and is a preparation for life-long learning), and promotes active and deep learning. It often includes or requires peer teaching, which encourages students to digest information so that they can present it to the group with some degree of authority. But also it taps into existing knowledge (possessed by members of the group), and this again has to be digested knowledge

so that it can explained and used confidently. Re-using knowledge reinforces the processes of remembering and digesting. There are many learning skills to be accumulated on the way, and these are developed in context and indeed the whole process, from the functioning of the group to solving the problem, will not work unless these skills are mastered. And in the end, PBL encourages, and indeed requires, reflection on the learning process: how did it go this time, and next time will the team do it more efficiently and more effectively?

There are those who believe that PBL has not always been successful (Glew, 2003) but this may be a result of its not being implemented properly rather than there being a basic flaw in the method (Hughes & Wood, 2003; Barrows, 2003). This issue has been discussed at some length recently (Herried, 2003). There is no doubt that if the method is not supported wholeheartedly by the academic staff who are required to use it, then it will certainly be less effective (Newman, 1993), and this problem has arisen in a number of medical schools. To quote Margetson (1991):

"*Why does the idea of problem-based learning evoke remarkably strong, even vehement reactions? Why does the idea often generate a surge of passionate hostility which tends to swamp what should be the careful consideration of an educational issue?*"

Hounsell and McCune (2002) mention that educational research has found it difficult to demonstrate positive effects of PBL on outcomes such as knowledge, critical thinking, reflective practice and teamwork, although it does seem to have positive effects on clinical performance, and on students' approaches to studying and motivation (see Shin *et al.*, 1993).

PROBLEMS OF PROBLEM-BASED LEARNING

Aside from any philosophical objections to PBL as an educational method itself, and aside from its not being welcomed wholeheartedly by staff, there are certainly problems in implementing a PBL curriculum, problems for the institution, the staff and students (Wood, 1994). These will be discussed very briefly here: they help us to understand which there is sometimes less than enthusiastic implementation of PBL.

Students

Students are familiar with traditional methods and may feel threatened in a different system. There does not appear to be a fixed curriculum and no textbook, so they feel (at least initially) that they do not know what they should be learning. In the group sessions they may have to work quite hard and be active – a different activity than sitting taking notes in a lecture. They may also worry about their performance in the group where all the students have different knowledge and skills.

Self

The traditional teacher who has knowledge to give is changed to the facilitator whose job is to encourage the students to learn for themselves. The possession of expert subject knowledge no longer seems to be valued and the teacher may suffer from a lack of self-esteem. Furthermore, with a range of problems being set, the facilitator may have no more knowledge in a given subject area than the students. There may also be concerns about how to run a small group and perhaps how to design and deal with problems. Most of all the teacher-cum-facilitator feels a lack on control.

Staff

The academic staff experience similar problems to the individual teacher, but there may be other issues, not least whether all the staff can be "converted" to the idea of PBL as a teaching method. The staff may also believe that there is now no longer a 'gold standard' of knowledge, here again because PBL appears to devalue knowledge as such. Academic expertise seems to be devalued and be replaced by a 'softer currency', that of running a small problem-solving group! Staff will almost certainly be unfamiliar with areas outside their own disciplines.

Institution

Traditionally we are happy with departmental structures based around scientific disciplines, and the very idea of PBL is interdisciplinarity: the only knowledge that is appropriate is the knowledge required for solving a particular problem. Although we each, in our own departments will admit that there is too much knowledge and that the amount is increasing exponentially, none of us is prepared to teach less.

With larger numbers of students on courses, PBL may appear to be very inefficient as a way of teaching. One person can give a lecture to 400 medical students, but some 50 facilitators will be needed to run PBL in groups of 8. However, one should not confuse apparent efficiency with effectiveness in engendering learning. Nevertheless is must be a departmental or institutional decision on whether to adopt this method of education.

Another issue is around whether PBL should be adopted as a teaching method (already referred to above). It is vital to have all the staff 'on board' and believing in the system or at least willing to try it out with some enthusiasm. At the institutional level the message is that "you need a strong Dean" to carry the transformation through.

Assessment

Finally, there is a problem about assessment and whether traditional examinations are appropriate for students exposed to PBL. There has been much discussion about this and it is important because students need grades to judge how they are progressing, the institution needs grades to supervise the progression of students from year to year, and professional bodies such as medical and dental councils need standards by which professional competence can be assessed and assured. Probably our traditional forms of assessment are to some extent satisfactory, but it may be more appropriate to set questions of the Extended Matching Sets type (Wood, 2003), or questions of the type "Here is a patient's symptoms and blood values. What would you do in this situation?"

CONCLUSIONS

Many medical and dental schools are using PBL and not all of these are graduate courses as in N. America. Many other schools, and not only medical and dental schools, are using PBL to a greater or lesser extent (e.g. nursing, engineering, law). There is nothing wrong in using a mixture or traditional and non-traditional methods if that suits the course and the institution in question. Probably PBL is less used at least on an extensive scale in Biochemistry departments, but many do have problem-solving classes which are successful. For those who want to discover more I can only recommend the Boud & Feletti book (1999) which gives a very balanced view of the benefits and problems of PBL.

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