IS PROBLEM-BASED LEARNING A GOOD WAY TO TEACH MEDICAL STUDENTS?

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INTRODUCTION

Problem based learning (PBL) was implemented in 1969 at McMaster University (Hamilton, Ontario) as a new way for medical students to learn. It grew as people were unhappy with the burden of factual information required.⁽¹⁾ The workload increased further with the advancements of twentieth-century medicine.⁽²⁾ Spaulding (one of the pioneers of PBL) stated: 'Students... became saturated and bored with the vast amount of information, much of it seemingly irrelevant to practice which, as passive recipients, they had to absorb.' He adds, 'shoving a lot of content down their throats because they don't retain it very long anyway.'⁽³⁾

Many versions of PBL exist, making it hard to define. These include hybrid courses which combine aspects of PBL with lecture-based conventional curriculums (CC).⁽⁴⁾ Students work in groups of five to nine. The students have a facilitator, who helps guide and motivate the group but allows students to lead the learning.⁽⁵⁾ The students are given a problem (usually in the form of a scenario) and are asked to define learning objectives which will tell them what information is needed to solve the problem. This problem has the basis of a real-life situation. The students then work on the learning objectives in their own time and have one or two more meetings to discuss the newly learnt information and its relation to the problem. Other activities, eg formal communication skills classes, clinical skills workshops, and hospital/community-based education, aid in their spiral of learning revolving around the problem(s).

The General Medical Council (GMC) article 'Tomorrow's Doctors' highlighted the GMC's new emphasis in medical education.⁽⁶⁾ This centred around preparing students for their role as a doctor via student-directed learning and understanding, rather than the learning of large amounts of what it said was 'irrelevant knowledge'.⁽⁶⁾ One of the effects of this was to see a large number of medical institutes change from CC to PBL curriculum. Because of the potential effects of PBL on the production of competent doctors, and thus the future of the NHS, it is important to know if PBL is a good way to teach medical students. There are many parts to this question. This account reviews whether PBL is likely to produce a better understanding of subject matter, in comparison to CC.

SETTING THE SCENE OF WHAT IT MEANS TO UNDERSTAND

Like PBL, no universal definition of 'understanding' exists, so it is important to create one within the premises of this review. The definition is based on neuroscience research at the Redwood Neuroscience Institute (Menlo Park, California).⁽⁷⁾

Understanding allows the student to make predictions not initially known by the student, based on logic that the student uses. Using two pieces of knowledge a student can work out a third piece of knowledge by understanding how the two initial pieces of knowledge interact with each other. If either one of those two initial pieces of knowledge was missing, the student would not be able to work out the third piece of knowledge. Rote learning the two pieces of knowledge without understanding would hinder the student being able to work out the third piece of knowledge. In real life this means the student can relate new-found knowledge to the wider web of knowledge he already has, eg know where the knowledge fits in with all the knowledge he/she has learnt in their life up to that point. New predictions can then be made from this. This usually comes from applying the knowledge in a different context to the one learnt in, making the knowledge flexible. This allows one to see the different application of the use of the knowledge, know when, where and why to use it and for what reason as to get the best effect out of it. This is all done by making predictions about the knowledge in a different context to the one it was learnt in.

This is why it is important for a doctor to understand the material. In medicine we are not given all the contexts in which to apply our knowledge and so we must make predictions of what will happen in situations that we have not been in before, so that we know how to deal with them. The anatomy and pathophysiology of the heart is only useful when a doctor can use it to make predictions about what will happen in the aid of their future clinical practice.

METHODOLOGY OF LITERATURE SEARCH

A search of Medline (via Ovid) using the term 'Problem-based learning curriculum' returned 117 results published between the years 1980-2009. A further search of Medline (via Pubmed) using the terms 'Problem-based learning' (amongst others) and 'understanding', and restricted to clinical studies on humans, returned 19 results. In order to obtain further results, terms such as 'clinical', 'higher cognitive', 'cognitive function', and 'interdisciplinary' were used, as well as searching via Metalib (of Lancaster University) under the health sciences section using the term 'Problem-based learning curriculum'. Metalib retrieved the top 30 results from each one.

Because of the amount of literature and the large number of confounding factors in each study (as a result of the difficulty in using randomised trials) I looked for trends in a general overview of the literature. This diluted the confounding factors (assuming no common factors occurred) while maintaining credibility for any strong trends perceived.

SURROGATES OF 'UNDERSTANDING'

Since few studies directly tackle the issue of understanding, surrogate markers were used in most studies as indicators of understanding. Showing understanding via the application of knowledge was considered an important marker as it showed doctors' abilities to use their knowledge in the different contexts. I first checked the effect of PBL on knowledge (using basic science exams as indicators for knowledge acquisition only, since basic science exams mainly test knowledge rather than understanding) to make sure any effects on application did not result from effects on knowledge. I then used 'clinical skills' and 'physician competencies' of doctors to show application of knowledge. Another surrogate marker was evidence of understanding how the different disciplines of medicine come together as a result of the links between disciplines and how they interact. The last surrogate involves evidence of higher cognitive functioning (analysis, synthesis, evaluation), as to do so requires heavy use of understanding. This can be shown in varied ways including active problem solving, more varied and original rather than repetitive approaches, critical questioning, reasoning, etc.

My criteria for inclusion in the review include: having a surrogate marker for understanding; at least one cohort of students having been taught using the PBL curriculum (based on the definition given above); and at least one control cohort where the students had been taught using CC. Also, because it was the effect of the PBL curriculum that I am looking for, studies using courses other than that of medicine were included, eg nursing, dentistry, etc. Hybrid courses were excluded from analysis.

RESULTS AND DISCUSSION

Twenty-three studies in the literature search provided evidence on the knowledge acquisition of students from the PBL curriculum, while 15 studies provided evidence on application of clinical skills, 13 studies evidence on other physician competencies, 11 studies on higher cognitive abilities, and nine studies on interdisciplinary understanding. Out of all the studies, five were meta analyses.

Some studies indicated that students may be performing worse in terms of basic science knowledge acquisition than students taught using CC. There was also indication that students were less confident about the level of knowledge they knew. Some studies indicated that PBL students did slightly better. However, the majority of studies failed to show significant difference. If PBL has a negative effect on knowledge acquisition, it is on a whole seen to be insignificant. Because knowledge is needed for understanding, an effect on the former will cause an effect on the latter. Since our results indicate that PBL does not have a significant effect on knowledge acquisition, the effects on understanding are also likely to be minimal.

It is claimed that students who have studied in a PBL curriculum have improved clinical skills. The evidence for improved clinical competence came in many forms. For example, some studies indicated PBL students' improvement in clinical skills examination. Some studies used the National Board of Medicine Exams (NBME) as a measurement of outcome. PBL students did worse or achieved the same grades when comparisons were made using the NBME I exam (which examines basic scientific knowledge). When comparing the

NBME II exam (which examines clinical skills) PBL students did significantly better. Other evidence was qualitative, coming in several forms including 'integrating science into clinical skills', 'more accurate diagnosis', 'an increase in clinical reasoning', 'understanding the principles that link concepts', increase in diagnostic precision, etc. No studies reviewed indicated that PBL students demonstrated worse clinical skills than CC students.

Other physician competencies were also seen to have improved in students taught using PBL. One study showed PBL students having an advantage on examination questions relating to physician competencies under clerkship. The majority of studies, however, showed outcome measures in qualitative, not quantitative, changes. There was an overall improvement in evaluations from senior doctors in charge of house officers who had been taught via PBL. Also, in studies which measured a variety of professional competencies and skills (in the same study), PBL students came out on top, or the same, as CC students on most competencies. In one study, PBL scored better on every competency. Statements from the conclusions of studies include: that PBL students 'felt more prepared', 'had better skills relating to the patients', 'were better team workers', etc.

Some studies directly mentioned increased cognitive abilities, eg strong thinking, critical thinking, PBL students having deeper approaches, etc. Studies even mentioned students having better comprehension and understanding. For the majority of studies, higher cognitive function was shown in another form. The most common form was versatile approaches to problems. This was mentioned in the form of reasoning, transfer of concepts to new problems and problem solving. One study, however, indicated that a minority took the opposite approach and started performing superficial thinking instead, ie the group became 'polarised' between deep and superficial thinking.

Two situations suggested evidence for gain of interdisciplinary knowledge via understanding. Some studies mentioned it directly as a perceived outcome of the study. Other studies stated the use of one discipline in relation to another, eg using biomedical knowledge in clinical practice. In one study, observers mentioned the likely reason of improved skills as interdisciplinary knowledge and this was included.

LIMITATIONS OF ANY CONCLUSIONS WE CAN MAKE FROM OUR RESULTS

There are several reasons why the literature obtained would not allow accurate conclusions to be drawn. Many studies are described and there are too many limiting factors to mention in this review. Tentative conclusions, however, can be made on general trends.

Examinations are predominantly a test of factual recall and it was difficult to relate examination success to what can be described as 'understanding'. Most studies looked at examination success, so were limited in their ability to measure the development of understanding. The measurement of the latter requires a qualitative approach rather than a quantitative one. Qualitative approaches are prone to observer bias in the absence of universal guidelines. They are also prone to reporter bias and, as they are describing results of a novel way of education, publication bias.

The only thorough way in which the two curricula can be compared is with cohort and longitudinal studies. The information is limited by selection bias – students choose the curriculum that they consider best suits their styles. It is impossible to claim that the PBL courses themselves are responsible for the claimed results, since they may be chosen by particular students who will do well in them.

Cohort studies that compare the outcomes of two different universities (one PBL, one CC) have the flaw that common unrecognised confounding factors may exist. Because there are so many variations in the different courses it is hard to attribute if the difference in results is due to PBL. I tried to reduce this by looking for generalised trends to balance the factors. However, more in-depth analysis with students and teachers would have to be conducted to make sure that this is the case. This would be to make sure that there is no common confounding factor that has affected the results, although one can be confident of the results if a strong trend is perceived.

Longitudinal studies use the same university before and after the curriculum change. These remove many of the confounding factors that occur between universities. Other confounding factors still exist however. It is hard to know how much of the results can be attributed to PBL and how much to other factors. Examples include the introduction of formal teaching of communication skills, community-based education, earlier introduction of clinical skill training, more time spent in clinical skills training, etc. In one university, the final year of medical training is spent over-shadowing a foundation year doctor. This allows the students to develop better physician/clinical competencies and understanding which cannot be discerned from having an impact on our results.

EXPERIENCING THE NEW CURRICULUM

It is important that what is presented by the empirical evidence is reflected in the experiences of those involved within the PBL process. Empirical evidence may guide understanding, but if it contradicts what is being experienced by medical students in PBL curricula, there develops room for concern. I have also therefore checked case reports of students within the PBL environment. One example includes an article published by Poyser; a medical student at Lancaster University medical school.⁽⁸⁾ Poyser mentions how PBL has allowed him to 'efficiently learn what is needed'. He has also mentioned how the PBL curriculum has allowed students to be better trained in communication, as well as ethical skills, and produce better results in objective structured clinical examinations (OSCE). He importantly mentions how PBL students develop methods in gaining knowledge that relate to their present level of understanding (eg when a student is presented with a clinical case that needs extra knowledge for the diagnosis and management of the case). This, and other, case reports are consistent with the conclusions made within this study.

CONCLUSION AND FUTURE IMPLICATIONS

Surrogate markers for understanding were used: these were clinical competencies, physician competencies, higher cognitive functioning and interdisciplinary knowledge. For three of these surrogate markers a strong definite trend was perceived. However, as shown, this review cannot provide

results which can assertively answer the question. It does, however, help shed light in several areas.

Clinical and physician competencies do improve in PBL courses and that it is not the result of increased learning. This suggests that no changes should be made to the current way that PBL is run, as it is producing better physician and clinical competencies. However, future research may shed light as to which particular part of PBL this is as from current research we cannot be certain. The results of such research can help guide the construction of future PBL curricula.

PBL seems to provide strong evidence of having an effect on the higher cognitive ability of students. However, which students this affects, why, and how, is an area for future research.

There is insufficient evidence to show that a strong link between PBL and increase in interdisciplinary knowledge exists. However, this may be due to the lack of information on the subject. More emphasis may need to be put on this measure in future studies. There is likely to be a cause and effect bond (between PBL and interdisciplinary understanding), but more factors may be at play. Future studies may also be able to find better competency on their outcome measurements via the advancement of psychometric technology constantly being developed.^(9,10)

Overall there is good evidence to show that PBL produces an increase in understanding in comparison to CC. I conclude that this suggests that PBL is a good way to teach medical students. It is also evident that more research has to be done to know why this is, and how it can be used in the future.

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