Tutors' conceptualizations of problem-based learning in an undergraduate medical curriculum

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Gillian Maudsley

Abstract

Background--- There has been a wide-ranging response from British medical schools to the 1993 *Tomorrow's Doctors* curricular recommendations from the General Medical Council. The undergraduate medical curriculum at The University of Liverpool was comprehensively reformed to become Faculty-managed, problem-based, integrated, and community-orientated, using a 'core plus options' approach, early clinical context, and four guiding curricular themes (including public health education - *Population Perspective*). The problem-based learning (PBL) tutorial became the main 'new curricular building block' for the first cohort of medical students entering in October 1996. The first-ever PBL tutor encountered by students is potentially a particularly influential role model. PBL appeared difficult to conceptualize given some of the mixed messages evident about the nature of PBL.

Research question--- Compared with 'received wisdom', what spectrum of PBL concepts prevails amongst foundation PBL tutors in a problem-based undergraduate medical curriculum, and what are the educational (including the public health educational) implications?

In-depth exploration of the literature--- Firstly, the *changing expectations* of an undergraduate medical education are explored. The discussion focuses on the professional context (using public health education to illustrate conflicts and challenges) **(Chapter 2)**, and on the context for various aspirations to knowledge, understanding, thinking, competence, and clinical judgement **(Chapter 3)**. Secondly, *approaches to meeting such expectations* are discussed. Issues from the adult learning, experiential learning, and critical thinking (and problem-solving) literature **(Chapter 4)** are used to introduce problem-based education, particularly for medical undergraduates **(Chapter 5)**. The relationship between 'PBL', 'problem-based curricula', and 'problem-solving' are then explored. Thirdly, *practical aspects* of PBL are examined, specifically PBL in the Liverpool curriculum and three of its pioneering counterparts **(Chapter 6)**, and then PBL tutors' role and influence **(Chapter 7)**.

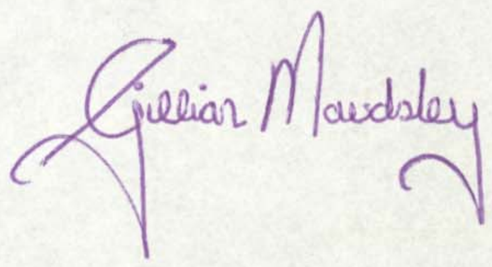
Fourthly, the methods **(Chapter 8)** and results **(Chapter 9)** of the *empirical study* of Liverpool's foundation PBL tutors are then described, and discussed in the context of the earlier discourse **(Chapter 10)**.

PBL tutor study--- Aim: To explore the way that foundation PBL tutors conceptualized PBL, problem-solving, the curricular themes, and their interrelationship (including reference to public health education). **Setting:** The University of Liverpool undergraduate medical curriculum, Year 1, Semester 1, 1996/97. **Subjects:** 34 foundation PBL tutors. **Design:** semi-structured interviews by telephone. **Analysis:** inductive analysis of qualitative data. **Results/Conclusion:** While most of the PBL tutors had grasped the main messages about the philosophy of PBL, confusion surrounded its more profound aspects, e.g. its relationship with problem-solving (and parts of the thematic curricular framework being used). The issues causing most difficulty coincided with pockets of confusion in the literature.

21,992 words

"This work is original and has not been submitted previously in support of any degree, qualification, or course."

Name: Gillian Maudsley

Signature: 

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Special thanks to Janet Strivens for her time and her stimulating supervision throughout this work; and to all the first-ever Year 1 Semester 1 (foundation) problem-based learning (PBL) tutors (Liverpool undergraduate medical curriculum 1996/1997) for their participation and enthusiasm in the interview study; and for the wry smiles they provoked 'unseen' at the end of a telephone with their whimsical observations (intended or otherwise):

> *"[Implications of using these curriculum themes with problem-based learning.] Yes... several. Because I [think a lot about Structure & Function]. I don't really have much interest in any of these rather more softer concepts of 'life'. I had difficulty in guiding [in those directions as I couldn't see the link], except for the 'Alcohol' module, which was very good from that point of view... public health nonsense... we don't know what you do... test-tube and microscope [let's get back to them]... I don't have any real insight into what goes on in the public health department and even less into what GPs do..."*

> *"[The tutor's background], I think it makes a huge difference. I think, I think that... the impact of the tutor, particularly the first tutor... is going to make a big difference... You've got a clean sheet when you hit the first semester and the impact of the first tutor if he's idle... good... honest... eccentric... [will] make a great difference. [You wouldn't judge the outcome of the first Saturday of the Premier League... After three or four semesters, changing groups will get various perspectives, various colourings for the students... the assessments will keep them on track]. I think it would be quite difficult for me to conduct a PBL tutorial in matrimonial law and [vice versa]... theoretically possible but, more difficult."*

Contents

List of abbreviations

BMA	British Medical Association
GMC	General Medical Council
NCVQ	National Council for Vocational Qualifications
NHS	National Health Service
NVQ	National Vocational Qualifications
PBL	problem-based learning

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Chapter 1: Introduction

There has been a wide-ranging response from British medical schools to the 1993 *Tomorrow's Doctors* curricular recommendations from the General Medical Council[1].

The undergraduate medical curriculum at The University of Liverpool was comprehensively reformed to become Faculty-managed, problem-based, integrated, and community-orientated, using a 'core plus options' approach and early clinical context. The problem-based learning (PBL) tutorial became the main 'new curricular building block' for the first cohort of medical students entering in October 1996.

Staff development was required, in the new educational philosophy and methods, particularly for those becoming PBL tutors. In the first instance, in the first-ever semester, each of 32 groups required a tutor (for a series of 21 PBL tutorials).

As a 'foundation' PBL tutor, I perceived a substantial gap between the rhetoric of PBL (from the medical and educational literature, and within the Faculty of Medicine itself) and the reality of the role. This was informed from personal experience, and anecdotally from conversations with PBL tutor colleagues and students. The conceptualization of 'PBL' and 'problem-solving' appeared to be variable, compounded by a confusion of definitions from official sources.

There was also variable interpretation of the four curricular themes guiding PBL in Liverpool's 'core curriculum. One of these was *Population Perspective*, comprising public health education. This has been relatively neglected in traditional curricula but

was promoted and given new impetus by *Tomorrow's Doctors*, illustrating the scale of the Liverpool response.

Irrespective of the prevailing spectrum of PBL theory and practical interpretation, or potential idiosyncrasies of early volunteers, however, the first-ever PBL tutor encountered by students is potentially a particularly influential role model. The research question raised is therefore:

> *"Compared with 'received wisdom', what spectrum of PBL concepts prevails amongst foundation PBL tutors in a problem-based undergraduate medical curriculum, and what are the educational (including the public health educational) implications?"*

Consequently, this prompted an in-depth exploration of the literature and an empirical study of tutors' concepts:

> ***Aim:*** *To explore the way that foundation PBL tutors conceptualized PBL, problem-solving, the curricular themes, and their interrelationship (including reference to public health education).*

Firstly, the *changing expectations* of an undergraduate medical education will be explored. The discussion focuses on the professional context (using public health education to illustrate conflicts and challenges) **(Chapter 2)**, and on the context for various aspirations to knowledge, understanding, thinking, competence, and clinical judgement **(Chapter 3)**.

Secondly, *approaches to meeting such expectations* will be discussed. Issues from the adult learning, experiential learning, and critical thinking (and problem-solving) literature **(Chapter 4)** will be used to introduce problem-based education, particularly for medical undergraduates **(Chapter 5)**. The relationship between 'PBL', 'problem-based curricula', and 'problem-solving' will then be explored.

Thirdly, *practical aspects* of PBL will be examined, specifically PBL in the Liverpool curriculum and three of its pioneering counterparts **(Chapter 6)**, and then PBL tutors' role and influence **(Chapter 7)**.

Fourthly, the methods **(Chapter 8)** and results **(Chapter 9)** of the *empirical study* of Liverpool's foundation PBL tutors will be described, and discussed in the context of the earlier discourse **(Chapter 10)**.

Chapter 2: Expectations of an undergraduate medical education

Societal expectations of an undergraduate medical education are inextricably linked to the professional status of medicine. Medicine, the 'archetypal profession', is under growing pressure to renounce any *"complacent, defensive, or nostalgic stance"*[2(p382)] towards its rights and responsibilities (especially its service obligations), and this has major educational implications. This chapter explores the:

- sociological and philosophical explanations of professional status;
- relationship between the recommendations for undergraduate curricular reform from the General Medical Council (GMC) (*Tomorrow's Doctors*, 1993)[1] and wider health and educational issues;
- potential for improved public health education to address some of the current challenges to medical professionalism.

Medicine as 'a profession'

Despite medicine often being used to illustrate the sociology of professions, reaching consensus about defining 'a profession' is problematic (as noted by Barber[3]). Attempts have focused variously on professionalism as a[4]:

- single distinct ethical trait (i.e. well-developed code of practice);
- constellation of traits;
- mode of operation, i.e. as a strategic tool of occupational control.

Generally, the occupational groups that are accorded professional status provide personal services using scarce skills[5]. The highly prized 'professional' label confers

social standing through connotations of rigorous standards of ethics and competence, which in turn allow occupational control for higher rewards[3,4]. Professionalism has thus been viewed as both producer and product of industrial economies - a type of state-sanctioned regulation of market entry, competition, structure, and remuneration[4,6].

More specifically, Freidson argued that *the* core feature of 'a profession' is its autonomy to determine how its work should be performed and by whom[7]. Other characteristics such as prolonged training in a specialized body of abstract knowledge, licensing, and service orientation are important but less defining in Freidson's explanation[7].

Alternatively, Downie discussed the difficulty in defining 'profession' neutrally from necessary and sufficient characteristics and, therefore, favoured a 'family resemblances' approach[8]. Ideal characteristics bestowing social importance were identified from this evaluative philosophical perspective, and a profession was thus considered to be morally and legally legitimated by fulfilling five criteria[8]:

- having an eclectic knowledge-base and related skills and expertise;
- providing a service through a special relationship based on beneficence tempered with integrity, and protected by a bond of legal and ethical rights and responsibilities;
- having the broader social function of 'speaking out' on government policy and justice to inform the public;

- being independent of state and commercial influence (but responsive to financial and consumer accountability);
- being educated, not merely trained, i.e. being able to set skills within a wider cognitive context, continuing to develop those knowledge and skills, and doing so within a framework of values.

The 'special relationship' resurfaces in Dowie and Elstein's consideration of the 'clinical professions' as those with individual or team responsibility for managing individual cases, with practice based mostly on implied consent, and involving unavoidable risk and uncertainty[9]. The privilege of the professional relationship is, however, under concerted threat[2], a recent example being from National Health Service (NHS) reforms such as the 'internal market'. This introduction of business philosophy provoked discomfort. Business is usually excluded from professional status on the grounds of being motivated by 'self-interest'. As described by Downie, however, rather than *self*-interest per se, 'market transactions' illustrate non-tuism, i.e. considering <u>*everyone but*</u> *the client* (thus including, but not being restricted to, 'self')[8]. Conversely professional relationships are based on 'tuism', i.e. beneficence and integrity within ethicolegal bonds, hence professional conflict with 'business philosophy'[8].

From a sociological perspective, although professionalism is really a continuum, two main groups of health professions emerge:- 'leading' and 'lesser'. The 'leading' group (medicine, dentistry, optometry, and pharmacy) tend to be better-paid and male-

dominated. Generalizing further, medicine is in this group because historically it has had[5]:

- a university-based education (compared with the more work-based education of the 'lesser' group);
- an ability to generate and test its own knowledge-base (whereas the 'lesser' group tends to 'borrow' this research and generate less of its own);
- a gatekeeper role, controlling patients' access to the 'lesser' group.

The welfare professions that emerged with the rise of the welfare state have been unable to match the elusive status of medicine. This is because, in achieving professional status ahead of state intervention, medicine used a particularly advantageous market strategy in the 19th century[5,6]. Aspirants to health care professional status are no longer likely to attract similar improvements in financial rewards and working conditions.

The premier position of medicine even *within* the 'leading' group is attributable to its knowledge-base being perceived to be more abstruse and its outcomes less predictable relative to dentistry, optometry, and pharmacy[5]. Arguably, therefore, doctors are trusted more to police each other's use of their esoteric knowledge, because its mantle of mystique excludes 'outsiders' from performing this role. Nevertheless, Downie considered medicine, the classic paradigm of a profession, to fare well on all his five 'ideal criteria', *except* on being educated rather than trained! Calman and Downie were concerned that the medical profession overemphasized knowledge and skills at

the expense of humane values associated with being 'educated'[10]. The case for broader educational foundations and a broader concept of knowledge is growing.

Challenging medical professionalism is not for the faint-hearted. Like other professions, medicine self-propagates by selection and socialization[11,12], resisting outside contributions to its knowledge. Despite intentions to 'serve', the extreme view is that doctors value that which furthers their material and practical interests[5]. This potentially explains medical reticence to demystify the knowledge-base, to be informed by mainstream educational literature rather than dogma, or to value explicitly activity contributing to the 'public's health' (an issue for later discussion).

Undergraduate medical curricular reform and *Tomorrow's Doctors*

Traditional approaches to professional education in universities have been criticized for undervaluing the pivotal role of relevance and context, teamwork, and active enquiry[13]. Barnett noted the post-2nd World War shift in higher education curricula away from a disciplinary focus towards an action focus, in response to societal demands[14]. Professional education is urged to reflect contemporary societal needs and professionals to show more public accountability[14]. According to Barnett, the increasing demands for flexibility, communication skills, teamwork, and lifelong learning skills need to be met with more than just static *"pools of knowledge and expertise"*[14(p15)], because the knowledge explosion continues unabated:

> *"An avalanche of publications... [as] distracting noise that drowns out the few nuggets of credible knowledge and the even rarer glimpses of wisdom."*
>
> White and Connelly, 1992[15(p9)]

Margetson drew the analogy between hanging on to higher education curricula that have lost their point and Harold Benjamin's 'sabre-tooth curriculum'[16,17]. In this mythical tale, tribal elders retain a curriculum for hunting sabre-toothed tigers, long after the tigers have been hunted to extinction by highly successful curricular implementation, just because it is traditional[16]. Traditional undergraduate medical curricula are particularly under pressure to stop hunting extinct tigers.

The GMC has a statutory duty to promote high standards of undergraduate medical education, issuing curricular recommendations approximately decennially[1]. Currently British medical schools are responding, with a spectrum of curricular reform, to GMC recommendations of 1993 (*Tomorrow's Doctors*)[1]. As with many other initiatives around the world, such reforms are aimed at uncluttering undergraduate medical curricula, improving their educational robustness, and tailoring their product to prevailing public needs.

In this country, faults in 'traditional' curricular structure, process, and outcome have been accruing since the GMC first established a medical register in 1858 to regulate professional and educational standards[1,18]. Indeed, 19th century concerns about factual overload (through 'force-feeding'[19]) impeding understanding in undergraduate medical curricula remain relevant[1,20]. It is futile to try and keep pace with the inexorable growth (by 'creeping incrementalism'[21]) of the knowledge-base. Historically, the isolation of theory from practice has been counterintuitive and problematic, illustrated by the competitive divide between preclinical (basic science)

courses and clinical courses (clinical apprenticeships) that they were introduced to strengthen. Discipline-based vested interests have hindered attempts at preventing inefficiency and duplication by working jointly on common curricular content.

Undergraduate medical curricula are under pressure from internal and external factors. Internal curricular pressures arise from inability to circumscribe factual burden. External factors include major changes in: service organization, emphasis (e.g. towards primary care and prevention), and costs; professional roles; demography; morbidity; demand for non-conventional treatments; science and technology; public awareness and expectations; and perceived ethical issues[1,22]. These external factors are also, largely, 'public health-related'. International consensus was expressed in the Edinburgh Declaration that lifelong-learning, health promoting doctors are therefore needed, appropriate for the times[23], and consistent with the world-wide resurgence of interest in the 'public health function' in recent decades. The slow translation of such goals into comprehensive public health education for British medical students is unsurprising given the marginalization of public health medicine amongst medical specialties. *Tomorrow's Doctors* strengthened the position of public health education.

There is no single definition of the aims of undergraduate medical education, but contemporary priorities were highlighted by the *Tomorrow's Doctors* recommendations urging curricular change (**Box 1**)[1]. These highlighted approaches to reducing factual overload; promoting knowledge, skills, and attitudes for pre-registration 'house officer' year and beyond; and adapting to a climate of change, particularly patterns of health care. Improving communication and public health

education received specific attention, and problem-orientated, learner-centred education, including teamwork, was encouraged.

Box 1: *Tomorrow's Doctors* recommendations from the General Medical Council (GMC), 1993[1]

1. reduce *factual overload*;
2. promote learning through *curiosity*, exploration of knowledge, self-directed learning, and critical appraisal of evidence;
3. inculcate *attitudes* appropriate to a doctor's responsibilities;
4. teach essential skills for *pre-registration year*;
5. have a *core curriculum* of knowledge, attitudes, and skills for pre-registration ('house officer') year*;
6. have *special study modules* to augment the core curriculum and encourage a questioning and self-critical approach;
7. *integrate* basic sciences and clinical concepts in the core curriculum (eliminating the preclinical/clinical divide and exclusively department-based courses), and base the curriculum on body systems;
8. emphasize *communication* skills;
9. make *public health medicine* a prominent theme;
10. adapt clinical teaching to *changing patterns* of health care (primary, community, and hospital);
11. ground medical education in *modern educational theory*, draw on technological resources, and share good practice;
12. use *student assessment* that encourages appropriate learning skills (and discourages uncritical fact acquisition);
13. have effective *supervisory structures*;
14. *report regularly* on progress to the GMC.

Source: adapted from General Medical Council, 1993[1]

*The pre-registration year[24] follows graduation and involves 'supervised', salaried working on hospital wards while *provisionally* registered with the GMC. Its successful completion leads to full registration.

"We must ensure that... the newly qualified doctor is well prepared for the responsibilities of the pre-registration house officer year. For the rest, we can at best strive to educate doctors capable of adaptation to change, with minds that can encompass new ideas and developments and with attitudes to learning that inspire continuation of the educational process throughout professional life."

General Medical Council, 1993[1(p4)]

The argument for a public health education for medical students

The public health function has an uneasy relationship with mainstream medicine but is particularly relevant in an everchanging health care and professional climate. Delivered

via many service sectors and academic disciplines, public health has much to do with health promotion (i.e. the overlapping elements of disease prevention, health education, and health protection).

The foundations of public health are in epidemiology, the study of the distribution and determinants of disease in human populations. This scientific base contributes to the:

- investigation and prevention of the 'causes' of ill-health;
- construction of health strategy responsive to 'population health needs assessment';
- evaluation of health services, including investigation of the effectiveness of health-related interventions ('evidence-based health care').

The epidemiological focus is complemented by other disciplines (e.g. statistics, sociology, health economics, management, health promotion) and skills (e.g. facilitation, multidisciplinary-working and team-working, empowerment, education, advocacy) that have generally been undervalued in medicine. Indeed, differences in attitudes to social issues between members of the multidisciplinary health care team are already evident in undergraduate groups[25], and therefore have educational implications.

There are numerous macro-influences on undergraduate medical curricula and many of these are public health-related. Those identified by White and Connelly, together with social, financial, and political pressures, are that doctors must respond to changes such as the[15]:-

- 'information revolution', using the public health 'filter' skills of:

- critical appraisal (based on epidemiology and biostatistics);
- epidemiological analysis of population health problems (contributing to 'population health needs assessment');

– need for better communication skills;

– advances in molecular biology;

– environmental concerns;

– rise in health service management.

The relevance of public health education is therefore becoming easier to justify.

The history of the medical specialty of public health medicine, however, is littered with many arguments that remain unresolved from the 19th century, i.e. about its:

– name and role[26];

– relationship with clinical medicine[27] and undergraduate medical curricula[28];

– relationship with non-medical personnel aspiring to the professional status of public health doctors[29].

In taking a population perspective on health, public health medicine has no special individual relationship with patients, renounces private practice, understands 'managerial' approaches to health services, and tends, precariously, towards an 'honest broker' role between various health-related factions. This is anathema to traditional medical practice. Public health doctors explicitly do *not* fulfil Dowie and Elstein's requirement that clinical professionals be responsible for the care of individual patients[9] because, as with private practice, this would represent a conflict of interest.

Despite this, with public health advocacy as a core function, public health doctors *do* 'speak out' to or for the public on government policy, one of Downie's criteria for legitimating professional status[8]. Maybe Downie was being flippant in noting that *"it is **(almost)** plausible that the medical profession can speak with authority on matters of health"*[8(p158)]. As with much social commentary on medicine, however, the argument could be improved by revealing the contrasts, comparisons, and conflicts *within* medicine, the public health doctor being a useful example.

The longstanding dismissive approach of medicine to public health is predictable, and has been attributed to professional surrender of service ethic to self-interest[5]. As noted by Dowie and Elstein, however, medical ethics are based on deontological rather than utilitarian philosophy[30]. The 'goodness' of an action is judged by the former on its contribution to relevant rights and duties, rather than to 'the common good', as for the latter. For public health, as *"the science and art of preventing disease, prolonging life and promoting health through the organized efforts of society"*[31(p1)], its allegiance to 'the common good' therefore challenges that doughty competitor, traditional medical professionalism. Arguably, if medicine were comfortable with its obligation to the public's health, Woodward debating the motion that *Public health has no place in undergraduate medical education*[28] would have been unnecessary.

Nevertheless, the public health content of curricula is progressively moving from 'nice to know' to 'need to know'. Such improvements in public health education for medical students are part of international efforts to raise awareness of the population's health amongst medical schools and their graduates[15,23,32]. In ensuring that doctors

receive a minimum level of public health education[33], the tendency of the medical profession towards ignorance and resistance concerning public health principles, practice, and issues must be transcended.

Summary

Tomorrow's Doctors coincided with the increasing health care focus on lifelong learning skills to tackle expanding medical knowledge on a 'need to know' basis and deal with its uncertainties. The tendency of the 'evidence-based health care' movement (supported by public health philosophy) to deconstruct and demystify this knowledge-base challenges medical professionalism.

The GMC recommendations delineated the 'what' and, less eruditely, the 'how' for producing new doctors of maximum utility[1]:

- *What?* Medical graduates need to emerge equipped with an integrated core of basic and clinical science knowledge; communication, clinical, thinking, and learning skills; and appropriate attitudes. Such knowledge and skills should meet the practical needs of pre-registration year and provide a foundation for postgraduate medical training and continuing professional development.
- *How?* 'Problem-orientated' and 'learner-centred' approaches based on good educational practice were encouraged, including teamwork.

Chapter 3: Knowledge and skills for a professional education

The *Tomorrow's Doctors* recommendations[1] addressed factual overload in undergraduate medical curricula and inefficient use of the medical knowledge-base in nurturing clinical judgement. Where undergraduate medical curricula undergo comprehensive conversion to a problem-based format, the 'scientific foundations' of medicine are scrutinized considerably. This chapter therefore explores the:

- fallibility of the 'scientific' foundations of medical practice;
- role of knowing, understanding, and thinking in undergraduate medical education;
- need for a broad interpretation of competence and its relationship to transferability;
- clinical judgement.

The 'truth' in medicine

> *"...I have often seen barriers to communication and problem solving that at root are epistemologically based - that is, based on conflicting assumptions about the nature of knowledge and truth."*
>
> Kolb, 1984[34(p37)]

Science is perceived to be a meritorious commodity, and is revered in everyday life, the media, and academic and scholarly circles[35]; no less so in medicine. Traditional undergraduate medical education has its foundations very firmly in 'science'. Indeed, other health care professions attempt to emulate the supposedly transparent and axiomatic relationship between medicine and science.

Ironically, however, this relationship is rather strained and underpinned by a flawed philosophy that is likely to generate misconceptions about educational requirements. Medical students and doctors are often reminded that they are not 'real scientists' by basic scientists. Barnett noted that 'scientism' prevents recognition of 'tacit' knowledge integral to professional practice[14]. Such conflict is also reflected in the uneasy relationship between the basic science and clinical components of traditional undergraduate medical curricula, which tend to compete rather than complement.

Arguably, however, medicine has unknowingly identified with the less robust aspects of the philosophy of 'the scientific method'. In its haste to verify its truth claims, medicine has tended towards an approach to discovery that has not questioned the supposedly self-evident integrity of science. The reality of uncertainty[36] has been avoided.

Science is essentially quixotic, defying all-encompassing definition and with deceptively precarious foundations under scrutiny. Chalmers rejected two simple but inadequate rationalist expositions of science based on simple criteria, i.e. inductivism and falsificationism[35]:

- *Inductivists* consider the truth to be in experience. Facts gleaned from observation allow laws and theories to be formulated (by induction), which are used to predict and explain phenomena (with deductive reasoning logic). Simplistic inductivism is flawed because observation statements are fallible, generally being formulated using prior knowledge to interpret observations.

Sophisticated inductivists do not deny that it is wrong to assume that science starts with observation.

– *Falsificationists* take a more 'do or die' approach to science. With problems as the starting point, advances are made by learning from mistakes. Evidence is produced to falsify theories. New falsifiable theories are freely created to explain phenomenona and guide observations. They cannot be deemed true, only that they are the best available or better than previous versions.

Furthermore, Chalmers rejected the Lakatos view of scientific advance (supposedly typified by physics), a rationalist account focused on logical progress by systematic decisions of individual researchers or research groups[35].

Chalmers also rejected an opposing account of science, relativism, in which 'science' resides in quotation marks[35]:

– *Relativists* use criteria dependent on the values of the individual or society unlike any single absolute criterion beloved of inductivists or falsificationists.

Furthermore, Chalmers rejected the Kuhnian view of scientific advance, a relativist account distinguishing science from non-science by the existence of a paradigm[35]. In this account, Kuhnian scientific revolutions occur at crisis points in understanding, moving scientists from one paradigm to the next. This paradigm shift is not for some compelling logical reason but for a multitude of psychological and sociological reasons.

Chalmers maintained that[35]:

– *no* method can prove scientific theories to be true or probably true;

- *no* concept of truth is capable of defining science as a search for truth;
- *no* single category called 'science' can be delimited.

Indeed, Chalmers considered that science could only be adequately appraised as a *"historically evolving body of knowledge"*[35(p35)].

Such epistemological perspectives affect undergraduate medical curricula because, in summary, doctors:

- derive their professional status partly from being custodians of the medical knowledge-base;
- need to address both growth *and* uncertainty in this knowledge-base;
- need to appraise evidence critically to comply with the wishes of their registering body (the General Medical Council (GMC)) and main employer (the National Health Service (NHS)).

Acceptance of evidence for curricular innovation will be influenced by the perceived robustness, from the staff perspective, of the supporting 'science' and the proposed content and approaches. The precarious foundations of traditional undergraduate medical curricula, i.e. a view of science largely undermined by philosophical debate, are generally ignored. Fixed notions of worthy 'evidence', favouring knowledge acquisition, in terms of 'hard facts', over thinking skills, therefore need to be overcome.

Knowing, understanding, and thinking

Barnett characterized higher education as unique amongst institutions, in being the only one charged by society with *combining* all six knowledge functions: transmission, understanding, application, storage, critical examination, and development of knowledge[14]. The educational improvements envisaged by *Tomorrow's Doctors* are aimed at better thinking and learning skills grounded in understanding. It seems ironic therefore that just as undergraduate medical education is catching up with 'understanding', Barnett consigned it to the 'old' vocabulary of a higher education now in considerable philosophical flux[14]. Barnett's description of higher education as a meta-education, in which students *"develop the emancipatory capacities"*[14(p58)] to read a situation and select and apply the appropriate range of skills, however, is not at odds with the *Tomorrow's Doctors* mission.

'Learning for understanding' has been pivotal in the development of professional education. As described by Hamilton, 'understanding' was, historically, for learners destined 'to lead', driven by their need to take command of the unexpected (to use rather than merely reproduce technical knowledge)[37]. When Machiavelli challenged 15th century philosophy by asserting that human affairs could be determined by human free-will (and not *just* God and chance), this implied that state officialdom should be founded on understanding[37]. Consequently, between the 15th and 19th centuries, such humanistic notions progressively underpinned, firstly, state officialdom and, latterly, professional practice[37]. Machiavellian ideas provided the self-regulation

ethical framework for professionals, *"to harness (in both senses) their powers of free will and understanding"*[37(p62)].

Understanding is a difficult concept to describe:

- Hamilton's description of learning, as a journey from the starting state of learner readiness through the *"intellectual upheaval"* [37(p57)] of assimilating experience, identifies understanding as the arrival state (*"the mother of invention"*, *"the capacity to reach beyond the realm of recipe knowledge"*)[37(p60)].
- Holt considered understanding to be demonstrated when an idea can be explained in different words, illustrated with examples, recognized elsewhere, connected with other ideas, used flexibly, and its consequences and opposites can be identified[38].
- Wolf considered any disentangling of understanding from knowledge to be irrelevant, noting that National Council for Vocational Qualifications (NCVQ) guidance refers consistently to the 'knowledge and understanding' combination[39].

As well as 'understanding', *Tomorrow's Doctors* promoted 'thinking skills', the nature and educational implications of which should be set in a wider context of 'skills' as either motor *or* cognitive ('internal schemata' that guide action). Defining 'skill', De Bono, for example, was unable to improve on *"A skill is a skill"* but (like others[40]) clearly viewed thinking as a skill that could be taught[41].

Barnett identified four criteria for 'skill', i.e. that it is: complex, deliberate, meets the demands of a situation, and executed commendably[14]. Alternatively, '*a* skill' can be conceptualized as an organized activity that is adaptable with feedback and can become routinized[42,43]. Such notions do not therefore exclude thinking as a skill.

The skill of thinking (and of *critical* thinking) can be characterized in several ways:

- Thinking was defined by De Bono as *"the deliberate exploration of experience for a purpose"* (whether the purpose be understanding, decision-making, planning, problem-solving, judgement, etc.)[41(p33)]. Thinking, he proposed, is closer to wisdom than intelligence, being the operating skill through which intelligence acts on experience (using knowledge as the basic material).
- Halpern characterized thinking as developing abstract concepts to answer 'what would happen if...?' questions, and distilled a working definition of 'critical' (directed) thinking from the cognitive psychology literature[44]:

> *"...the use of those cognitive skills or strategies that increase the probability of a desirable outcome... purposeful, reasoned, and goal directed"*
>
> Halpern, 1997[44(p33)]

The focus on a specific outcome differentiates critical thinking from daydreaming, nightdreaming, and routinized habits (although certain elements no doubt have the tendency to become routinized). Halpern's favourite definition, however, was Russell's from 1960[45], i.e. that *critical thinking* = *attitude* + *knowledge* + *thinking skills*, because it resonated with contemporary notions of intelligence as having learnable components. Sternberg's Triarchic Theory of Intelligence, for example, involved *metacomponents* to plan,

evaluate, and monitor thinking[46]; *knowledge acquisition components* to use existing and new information; and *performance components* to think[44].

Arguably, doctors are more likely to use such sophisticated notions of 'thinking' (if at all) to understand patients rather than themselves, 'critical thinking' for professional practice thus assuming rhetorical proportions in much medical literature. Opinion has differed, however, over whether the educational literature has neglected[47] or been preoccupied[41] with 'critical thinking'. Overemphasis was claimed by De Bono, citing relative disregard of the messy imperfections of 'generative thinking', or the passive, descriptive, contemplations of 'scholarly thinking'. He attributed this to existing data being easy to criticize (especially when critics are not obliged to provide new data) and to the ecclesiastical origins of education[41]. Underemphasis was claimed by Brookfield, who characterized critical thinking as *"a lived activity, not an abstract academic pastime"*[47(p14)], a productive, positive, context-sensitive process, which is emotive *and* rational and responds to positive *and* negative events.

The GMC apparently wants medical students to epitomize critical thinkers. Halpern attributed to such individuals: flexibility; persistence; and willingness to plan, self-correct, be 'mindful' of their own thought processes (i.e. by 'metacognitive monitoring'), and be consensus-seeking[44]. The goals, as summarized by Halpern, are to[44]:

- recognize propaganda;
- analyse hidden assumptions in arguments;
- recognize deliberate deception;

- assess the credibility of an information source;
- work through a problem/decision in the best way.

Such purposes are relevant to contemporary medical practice and complement Brookfield's components of critical thinking: identifying and challenging assumptions, challenging the importance of context, trying to imagine and explore alternatives, and exhibiting reflective scepticism[47]. Realistic notions of scientific evidence, guarded by reflective scepticism, are in the *Tomorrow's Doctors* vision of a competent practitioner with a wider 'world-view'.

Competence, metacompetence, and metacognition

> *"...a higher education cannot be skills based. In a genuinely higher education, skills will, at most, form part of the repertoire of capacities to be developed and which graduates will, with discrimination and care, deploy or not according to their reading of a situation."*
>
> Barnett, 1994[14(p58)]

What lessons have competency-based approaches[48] for university production of 'competent' doctors? Competence is about meeting a standard, a controversial concept that is core to the GMC's regulatory role. Competency-based approaches, as exemplified by National Vocational Qualifications (NVQs), make explicit the method of assessing attainment of prescribed learning outcomes, and hence learning needs. It is self-evident and consistent with societal expectations that performance should not be inferred from knowledge alone, and that learners should be clear about the expectations of them. Such central tenets of the 'competence movement' would be difficult for universities to contest.

Nevertheless, higher education tends to distance itself from competence-based approaches, which are criticized for divorcing skills from the knowledge needed for adapting them to unpredictable situations. Challenged by the competence movement, the academic tendency is to question its relevance to higher education, equate it with routine practical work, and disparage its non-university origins[49].

In arguing that competence-based approaches should not be considered separately from education (or from learning generalizable and higher-level skills), Wolf made several points[39]:

- Competence is a construct involving performance to a given standard (e.g. set by the employer).
- It is the *process* of defining standards of competence that differs between occupation-based versus non-occupation-based activities, not competence itself. This is usually because, for the former, *"the utilitarian justification for developing a competence is direct and obvious"*[39(p40)] (e.g. for medical as opposed to philosophy graduates).
- Defining competence as synonymous with skill alone perpetuates a limited view of competence relating only to very specific practical activities. Competence can be inferred via outputs, i.e. behaviour, or less directly via inputs, i.e. knowledge and understanding, and skills. Focusing solely on outputs is compromised by the need for contextualization and for a great breadth of evidence.

- An 'evidence accretion' approach involving both inputs and outputs is preferred to infer competence. Separate assessment of 'knowledge and understanding' from the rest *is* necessary when occupations involve unpredictable and/or a wide range of different situations.

The large outer 'assessment gap' was identified by Fleming as the main challenge for university competence-based approaches[49]. This needs bridging to make 'safe' inferences from knowledge when competence cannot realistically be assessed in all potentially relevant situations[50].

Higher education, however, does not have its curricular foundations in clear concepts of 'competence', and there are difficulties, generally, with standard-setting in professional education. According to Barnett, these are that the[14]:

- standard is highly debatable and needs to accommodate public opinion because good medical practice, for example, is 'contested goods';
- standard cannot be divorced from curricular process implications as if only the outcome were relevant;
- graduates need to be able to respond to *and* shape a changing world, which is difficult to embed in 'a standard'.

Barnett argued that higher education is pushed to adopt the vocabulary of competence, but this merely replaces one closed view of higher education (i.e. serving cognitive culture) with another (i.e. serving the economy)[14]. The ideology of academic competence is swopped for that of one-dimensional operational competence[14]:

> *"Whether in the vocabulary of competence, outcomes, skills and transferability (the new) or of intellect, knowledge, truth, objectivity and disciplines (the old), we are faced with limiting ideologies."*
>
> Barnett, 1994[14(p5)]

Hodkinson also criticized the NCVQ's conceptualization of competence, but identified four potential lessons for professional education, i.e. that it could[51]:

- make professional practice more transparent;
- facilitate learning, by deconstructing a daunting role for the novice;
- clarify expertise, by distinguishing functional levels;
- facilitate assessment, by making it more holistic.

Sociologically, it can be argued that deconstructing and routinizing the work of certain occupational groups by dividing it progressively into specialized tasks leads to deskilling and 'proletarianization'[5,52]. Attempts to characterize and measure its educational components therefore challenge professionalism.

Fleming attributed the academic unease with competence-based approaches to having missed the linking role of 'metacompetence'[49]:

> *"Developing metacompetence is about lining subject-specific knowledge with the particular competences that should be practised by the learner."*
>
> Fleming, 1991[49(p11)]

According to Fleming, higher education fosters the development, however unknowingly, of this higher-order competence, which acts on other competences and allows their development, selection, and use in different situations. Metacompetence applies a critical adaptable perspective to other specific competences, facilitates change, and sets them in *"a larger framework of understanding"*[49(p11)]. Indeed,

teaching content with flexibility, critical insight, and potential for change was core to the medieval disputation (when advanced university students justified their theses to selected opponents in official readings)[49]. This blend of knowledge, performance, and occupation illustrated metacompetence.

In NVQs, range statements attempt to bridge the perceived knowledge-competence gap, providing a 'horizontal' element to complement the 'vertical' element of metacompetence[49]. Fleming distinguished between knowledge[49]:

- for 'its own sake';
- genuinely underpinning competence;
- allowing competence to extend beyond the limits of the situations in which it can realistically be assessed;
- allowing the competence to *"understand itself"*[49(p11)], i.e. informing metacompetence.

Hyland, however, criticized this sub-compartmentalization of knowledge (and that any knowledge could be 'for its own sake'), preferring the concept of vocational or occupational expertise to that of metacompetence[53].

The 'self-understanding' implicit in metacompetence resurfaces in the cognitive psychology literature in the closely related concept of metacognition:

> *"Until you 'KNOW WHAT YOU KNOW', you do not own your knowledge, and so you do not know anything."*
>
> Horwitz, 1989[54(p85)]

Such is metacognition, crucial in problem-solving[46], the seventh sense according to Nisbet and Shucksmith, in which learning processes are brought into consciousness[55].

Metacognition comprises higher-level ('executive') monitoring and controlling cognitive functions linking decision-making and memory, learning and motivation, and learning and cognitive development[56]. Metacognitive monitoring involves such functions as 'ease-of-learning judgements', 'judgements of learning', 'feeling-of-knowing judgements', and 'confidence in retrieved answers'[56], providing the personal insight needed to adapt skills to novel situations. Intellectual discomfort accompanies metacognition (as indicated by the adage used by Chalmers when exploring the meaning of science, *"We start off confused and end up confused on a higher level"*[35(pxix)]):

> *"The good student may be one who often says that he does not understand, simply because he keeps a constant check on his understanding."*
>
> Holt, 1982[38(p16)]

The GMC explicitly wants 'competent' graduates, flexible in thought and action, and yet its stance on 'competency-based approaches' is undisclosed. Barnett's concerns about competence-based approaches being ill-equipped for shaping and responding to change[14] are valid if they are not underpinned by 'knowing about knowing'. As Nisbet and Shucksmith assert, the distinct contribution of metacognition is to improve the capacity to transfer learning to new contexts, underpinning learning to learn by bringing the process to conscious level[55]. The next step is to relate this discussion to clinical practice.

Clinical judgement, technical rationality, and problem-solving

In tackling competence issues, undergraduate medical education needs to foster clinical judgement amid the widespread uncertainty inherent in medical practice. Clinical decision-making is beset by inter- and intra-observer and subject variation at several key points[57]:

- defining the disease;
- diagnosing the disease, via interpretation of symptoms, signs, and tests;
- assessing likely interventions given potential outcomes with particular patients (and their preferences);
- assimilating all this information to make a clinical management decision.

Eddy considered that doctors should confess the vagaries of clinical decision-making, and manage uncertainty scientifically using relatively neglected disciplines, e.g. statistics, economics, and decision theory[57] (again, tending towards a public health education). In accommodating such uncertainty, clinical decision-making can be conceptualized in several ways.

Barrows and Tamblyn characterized clinical reasoning as *the* cognitive process underpinning clinical evaluation and management of patients[58]. Usually referred to as problem-solving (but sometimes as medical enquiry, clinical judgement, and diagnostic reasoning), Barrows and Tamblyn were quick to dismiss any implication that the core medical task is one primarily of solving problems. They preferred a focus on managing insoluble problems. The issue of medicine as art or science therefore resurfaces:

"Are the manifold uncertainties of contemporary clinical practice to be seen as the legitimate basis for regarding clinical judgment and decision making as significantly - even 'essentially' - artistic in character? Albeit, of course, an ***art*** *that uses, and gains credibility from, the knowledge produced by the medical and other* ***sciences****. Or are claims to artistry just the way the profession dresses up its refusal to apply the same scientific approach to its own cognitive processes and behaviour that it insists upon in relation to processes and knowledge at the levels of organ and cell?"*

Dowie and Elstein, 1988[30(p4)]

Barrows and Tamblyn considered that, in trying to appear 'scientific', doctors engage in some dangerously inaccurate personal introspection when explaining their practices to students[58]. They do not arrive at decisions in the ways that they perceive that they do:

"To rearrange your cognitive steps to fit the acceptable medical 'norm' is not unlike tidying up the house for company so that they will think you are a good housekeeper."

Barrows and Tamblyn, 1980[58(p21)]

Nevertheless, Barrows and Tamblyn allied themselves with the scientific method, summarizing the hypothetico-deductive model of medical problem-solving as[58]:

- information perception and interpretation (selecting cues and forming the 'initial concept');
- hypothesis generation (of 2-5 hypotheses);
- enquiry strategy and clinical skills (taking a 'search an scan' approach to data collection);
- problem formulation;
- diagnostic and/or therapeutic decision-making (reaching 'closure').

Schön was critical of technical rationality being the dominant epistemology of professional practice, i.e. problem-solving made rigorous by the application of science

(while denying any role to craft and artistry)[59]. In this positivistic model, professional knowledge is considered to be specialized, circumscribed, scientific, and stereotyped for problem-solving[59]. General principles are at the top of the knowledge hierarchy, and problem-solving at the bottom. Prescribing 'theory before practice' is a way of trying to legitimate the preclinical-clinical divide in undergraduate medical curricula but technical rationality is, however, limited by the dilemma of rigour or relevance:

> *"The difficulty is that the problems of the high ground, however great their technical interest, are often relatively unimportant to clients or to the larger society, while in the swamp are the problems of greatest human concern."*
>
> Schön, 1983[59(p67)]

Public health doctors are probable inhabitants of Schön's 'swampy lowlands', because population-relevant problems tend to challenge conventional notions of science, hence the traditional medical resistance to public health education.

Schön was more impressed with the intuitive craft-like aspects of clinical decision-making, i.e. 'knowledge-*in*-action' and 'reflection-*in*-action' rather than '-for-action'[59]. The element of surprise is pivotal in reflection-in-action, which is a response to unexpected results from intuitive performance allowing uncertainty to be accommodated[59]:

> *"The dilemma of rigor or relevance may be dissolved if we can develop an epistemology of practice [that] places technical problem solving within a broader context of reflective inquiry, shows how reflection-in-action may be rigorous in its own right, and links the art of practice in uncertainty and uniqueness to the scientist's art of research."*
>
> Schön, 1983[59(p76)]

'Reflection-in-practice' may actually last for months limited only by the length of the 'action-present' (e.g. a series of clinical cases presenting over several months)[59].

In the Dreyfus Model of Skill Acquisition (developed from studying chess players and pilots)[42], five levels link the technical with the intuitive aspects of clinical expertise (as summarized by Benner concerning nursing)[60]:

- Level I (novice): cannot use discretionary judgement and learns rules for action according to specific characteristics of a situation.
- Level II: (advanced beginner): can perform to an acceptable level and, because of prior experience, will notice *"recurrent meaningful situational components... aspects"*[60(p403)] (general characteristics of a situation), but needs support to prioritize.
- Level III: (competent): lacks the speed and flexibility of proficiency but analyses, prioritizes, and plans action, and assumes mastery and ability to cope with contingencies.
- Level IV: (proficient): perceives situations as wholes not just aspects, is guided by situationally-dependent maxims, and recognizes abnormality.
- Level V: (expert): only needs to resort to analytical tools, rules, and maxims in novel situations, and can see what is possible and what is not worth pursuing.

Progression is from relying on abstract principles to incorporating past experience, and from perceiving situations as comprising equally relevant pieces to a whole in which only some pieces are relevant[60].

Benner warned against fractionating the expert nurse's performance because, according to the Dreyfus model, progression is not about internalizing rules and formulae but abandoning them as practical experience becomes available as

paradigms[60]. A holistic approach to describing the outcomes of expert performance was recommended by Benner, acknowledging that experts are unable to articulate every relevant step in their practice[60].

Summary

The fallible scientific and professional foundations of medicine are challenged by promoting more efficient approaches to knowing, understanding, and critical thinking, and in embracing the concepts of competence, metacompetence, and metacognition to adapt to a climate of change. There are tensions between the technical rationality approach to problem-solving/clinical judgement, based on the hypothetico-deductive model, and the professional artistry approach concerning reflective practice. Experience is central to the hierarchy of skills acquisition from novice to expert.

Chapter 4: Learning approaches for a professional education

Having related the expectations and ambitions of undergraduate medical education to conflicts and uncertainties in its professional and scientific foundations, several educational approaches illuminating the problem-based route will be introduced. This chapter sets the context for the ensuing exploration of problem-based learning (PBL), by outlining relevant aspects of:

- adult learning;
- experiential learning;
- potential and limitations of a problem-solving model of clinical practice; educational approaches to critical thinking and problem-solving.

Adult learning for medical students

The philosophy of *Tomorrow's Doctors*[1] has been widely supported. The British Medical Association (BMA), for example, reinforced the General Medical Council (GMC) recommendations by describing the future of medical education in terms of self-directed learning, elaboration, blended theory/experience, constructive feedback, a learning environment, and self-assessment[20]. Neither the GMC nor the BMA embellished, however, upon the recommended use of adult educational theory, implicitly accepting, as self-explanatory, certain well-used phrases (just like 'good' science).

Medicine can be forgiven for naive and unreflective use of 'adult learning' language because, until relatively recently, the adult learner was Knowles' 'neglected species' in

education *generally*[61]. Until the 1970s, there *was* no comprehensive theory to challenge the age-old, unreflective ideology of 'pedagogy', i.e. *"the art and science of teaching children"*[61]. Knowles' non-ideological conceptualization of andragogy, however, now underpins much adult education, involving learners[61]:

- knowing why they need to know;
- taking responsibility for their own learning;
- using their own experience;
- being ready to learn;
- using life-centred, task-centred, problem-centred approaches;
- being motivated more by internal than external factors.

World-wide, such assumptions underpin various models of comprehensive undergraduate medical curricular reform. The more progressive problem-based medical schools also aspire to Knowles' representation of a 'lifelong learning resources system', by[61]:

- facilitating lifelong learning (for an ever-changing world);
- being based on learner-initiated active enquiry;
- encouraging learner-learner interaction;
- being process- rather than content-orientated;
- developing competences for 'life situations';
- accommodating diverse experience, motivation, style, and speed of learners;
- linking learners with appropriate resources;
- helping the traditionally educated to become lifelong learners.

It is therefore implicit in GMC and BMA recommendations that medical students' education should be facilitated by whole, not fragments of, medical schools being immersed in the culture of andragogy. Furthermore, the notion that everyone has experience to share introduces experiential learning.

The relationship of problem-based learning to experiential learning

> *"The highest point of knowing is not knowing. Herein lies the paradox of learning from experience."*
>
> Brew, 1993[62(p97)]

Adult learners use their own experiences[61], and yet 'experiential learning' per se is somewhat enigmatic. Its very title can elicit *"the blankest of looks"*[63(p25)] from those unfamiliar with it and its many meanings.

Defining experience itself has tested many intellects[64]. As described by Mouly, 'experience' is one of the complementary and overlapping means of understanding phenomena, i.e. experience (personal or from friends/colleagues/experts); reasoning (inductive and/or deductive); or research[65]. Its meaning is, however, often taken-for-granted. Cohen and Manion distinguished research from experience by the former being systematic, controlled, and built on inductive-deductive reasoning; empirical (i.e. related by observation to 'objective reality'); and self-correcting[66]. This leaves experience merely as an unsystematic uncontrolled entity.

Nevertheless, there are more sophisticated views of 'experience':

- Benner used the term in the sense of *having* experience related to novice-expert levels, i.e.:

> *"...the refinement of preconceived notions and theory by encountering many actual practical situations that add nuances or shades of differences to theory."*
>
> Benner, 1982[60(p405)]

– Boud *et al* characterized *an* experience as an event with meaning (not mere isolated sensing)[64].

These views provide a broader perspective for disentangling experiential learning.

Advocates of experiential learning tend to relate their definitions to Kolb's experiential learning cycle[63] and envisage active learners taking responsibility for their own learning[67]. Kolb noted that the experiential learning approaches of Dewey, Lewin, and Piaget simulated the scientific method (for him the highest philosophical and technological refinement of human adaptation)[34]. Kolb built his cycle on shared characteristics from these three approaches, conceptualizing experiential learning as

"the process whereby knowledge is created through transformation of experience"[34(p38)], i.e.:

– process- more than outcome-orientated;
– continuous and grounded in experience;
– resolving dialectical conflict between opposite modes of adaptation;
– holistic;
– involving 'people-environment' transactions;
– creating knowledge.

Kolb's experiential learning cycle moves through concrete experience, reflective observation, abstract conceptualization, and active experimentation, grasping

experience on the 'prehension dimension' (apprehension-comprehension) and transforming it on the 'transformation dimension' (intention-extension).

Boud *et al* described five essential propositions of experiential learning (consistent with Kolb's work), i.e. that it[64]:

- has experience as its foundation and stimulus;
- involves learners actively constructing their experience;
- is a holistic process;
- is socially and culturally constructed;
- is influenced by the socioemotional context.

Introducing comprehensive conference proceedings exploring its meaning, Weil and McGill indicated that experiential learning:

> *"...whether personal, in use in formal institutions or in the community, is usually concerned with swimming against the mainstream to bring about change."*
>
> Weil and McGill, 1989[68](pxxi)

and ended the volume with a definition as unifying as possible given the diverse intervening discourse:

> *"...the process whereby people individually and in association with others, engage in direct encounter and then purposefully reflect upon, validate, transform, give personal meaning to and seek to integrate their different ways of knowing. Experiential learning therefore enables the discovery of possibilities that may not be evident from direct experience alone."*
>
> Weil and McGill, 1989[69](p248)

Four 'villages' of theory and practice were identified, by Weil and McGill, in the 'global village' of experiential learning, each focusing differently[70]:

– *assessment and accreditation of prior experiential learning to allow access to, or recognition from, educational institutions, employers, and professional bodies:*

  This is outcome-orientated; promotes opportunities and self-esteem for disadvantaged groups; and gives learners responsibility for producing evidence to support claims for knowledge and skills.

– *change in the practice, structure, and aims of post-compulsory education:*

  This is process-orientated; aimed at educational change, 'learning to learn', and spans teaching techniques to learner-centred total educational philosophy. Process and outcome are inextricably linked. Previous experience is a valued resource for active, meaningful, and relevant learning.

– *social change, mostly outwith educational institutions:*

  Learning from experience stimulates group consciousness-raising, community action, and social change. 'Commonsense assumptions' and 'taken-for-granted experiences' are challenged through group reflection.

– *personal growth and development (potential and practice):*

  A climate of risk-taking, support, and challenge increases personal and group effectiveness, autonomy, choice, and self-fulfillment, and ranges from therapeutic and counselling approaches to development approaches.

All four villages use 'experience', but types and approaches differ.

PBL shares not only definitional confusion[71] with experiential learning, but also features placing it in Weil and McGill's 'village' of post-compulsory educational

change. These features comprise valuing and building upon prior knowledge, and fostering active and meaningful learning relevant to clinical medicine.

The reflective nature of experiential learning also surfaces in PBL. Given the current imperatives to cultivate reflective medical graduates, and temporarily setting aside philosophical and semantic confusion between PBL and problem-solving, educational approaches to critical thinking (and problem-solving) will now be considered. As with experiential learning, contemporary concern with critical thinking is attributable to the work of Dewey[72].

Educational approaches to critical thinking and problem-solving

> *"...knowledge is no more a substitute for thinking than thinking is a substitute for knowledge... There are too many brilliant academics whose brilliance in their own fields and lack of it outside those fields shows the difference between knowledge and thinking."*
>
> De Bono, 1978[41](p14-15)

Opinion differs over whether critical thinking is 'teachable', but Coles and Robinson considered the evidence to be supportive if the activity specifically and *consciously* aims to do so[73]. For them, thinking could be taught if encouragement and opportunity were complemented by guided practice using appropriate principles and techniques[73]. They, like De Bono[41], considered the 'by-product' approach untenable. Alternatively, Brookfield argued that, despite the compelling label ('critical thinking', 'critical analysis', 'critical awareness', 'critical consciousness', 'critical reflection'), *exhorting* learners into critical thinking is unhelpful and counterintuitive without a modicum of consent[47]. He also warned that self-proclaimed gurus of critical thinking should be scarce, given that they should be sceptical of their own claims to the ultimate truth[47]!

According to De Bono thinking skills are teachable[41], by teaching perception rather than logic, and that it is about consciously practising thinking skills not learning thinking skills. For De Bono the 'teaching the obvious tag' is a barrier to overcome with meaningful content[41]. Misrepresenting thinking as a passive, somewhat idle pastime is likewise a barrier that Brookfield was keen to dismiss by arguing that thinking *is* action and sharing personal insights into developing a critical edge[47].

Brookfield's 'theory in use' about facilitating critical thinking, i.e. his *"'real' story..., [not] the fine-sounding and lofty (but basically unrealistic) prescriptions found in textbooks..."*[47(p72)], came from reflecting on personal and professional practice:

- *The process* is person-specific, emotion-centred, and intrinsically *and* extrinsically motivated; often leads to critical insight unexpectedly; and, crucially, requires peer support.
- *The 'rules of thumb'* for the facilitator are that there is no standard approach, diverse methods and materials are essential, perfection is impossible, learner satisfaction is not the sole aim, and risk-taking is important.

Particularly, Brookfield considered risk-taking to involve capitalizing on *"teachable moments"*[47(p81)] when the imagination of the group is fired, serendipitously[47]. Brookfield also outlined useful strategies for developing critical thinkers[47]:

- affirming self-worth;
- listening attentively;
- showing your support;
- reflecting and mirroring their ideas and actions;

- motivating them;
- regularly evaluating the process;
- helping them to create social networks with like-minded learners;
- being critical teachers;
- raising awareness of how to learn to be critical thinkers;
- being role models for critical thinking.

Problem-solving is covered in many 'compartments' of the literature beyond medical education (tending not to be accessed by the latter), e.g. its topicality as one of the six core ('transferable') skills units developed by the National Council for Vocational Qualifications (NCVQ), i.e.[74]:

- application of number;
- communication;
- information technology;
- personal skills: improving own learning and performance;
- personal skills: working with others;
- problem-solving *"clarifying problems and finding solutions"*[74(p5)].

Level 1 problem-solving involves selecting standard solutions to fully-described problems[75]. By level 5, aimed at higher education[76], specialist knowledge is extended to clarify complex problems with a range of possible solutions, including unknown/unpredictable features, and to identify alternative solutions and select solutions to such problems[75]. NCVQ approval for specifications for problem-solving were delayed, raising questions about the difficulties inherent in deconstructing

problem-solving. Barnett interpreted state encouragement of 'transferable skills' in higher education as acknowledgement that technical and scientific knowledge alone is insufficient for societal needs[14]. It is notable that Hodkinson criticized the NCVQ model of competence for oversimplifying the professional role and context by being based on *"rampant managerialism"* and technical rationality[51(p61)].

There are several ways of conceptualizing problem-solving that show some overlap with the hypothetico-deductive approach:

- In 1926, according to Halpern[44], Wallas hypothesized that problem-solving follows four distinct stages[77]. Despite psychologists disagreeing about whether *all* problem-solving follows these stages, they form a useful framework[44]:
  - preparation or familiarization (concerning nature of problem, goal, and givens);
  - production stage (of solution paths through 'problem space' from initial state to goal);
  - judgement or evaluation (of solution paths through the 'problem space');
  - incubation stage (sometimes leading to sudden knowledge of the solution when the problem is not being actively considered).
- Bransford and Stein labelled five basic steps in problem-solving using the acronym IDEAL[78]:
  - **I**dentify the problem.

- **D**efine and represent the problem.
- **E**xplore possible strategies.
- **A**ct on the strategies.
- **L**ook back and evaluate effects of activities.

– In Gagne's eight-level hierarchy of distinct types of learning, according to Knowles[61], each level is the prerequisite for the next. Problem-solving, as Type 8, therefore has signal learning, stimulus-response learning, chaining, verbal association, multiple discrimination, concept learning, and principle learning as prerequisites.

Problem-solving is therefore a complex activity that defies simple definition. It has a variable relationship with knowledge depending on the level of complexity.

Halpern considered there to be considerable overlap between problem-solving, decision-making, and creativity, with good problem-solvers persisting in searching for solutions even when an obvious or plausible one has been found[44]. In terms of creativity, it is the 'structured spontaneity' of brainstorming that prevails in the problem-solving literature (as pioneered by Osborn in the 1930s)[79]. Brainstorming rules encourage divergent thinking, i.e. that there should be[79]:

– no criticism of ideas;
– freewheeling;
– generation of as many ideas as possible;
– a record made of everything (even repetition);
– incubation of ideas before evaluating them.

Large numbers of ideas are therefore generated including outrageous ideas (to achieve quality through quantity); critical evaluation of ideas is discouraged until a late stage; and ideas are developed and integrated[80]. Indeed, this brings problem-solving back to critical thinking the other body of literature that is largely eschewed in discussions of medical problem-solving dominated by the hypothetico-deductive model.

Barrows and Tamblyn considered that to learn clinical problem-solving the various stages need to be brought to consciousness and considered[58]. Abercrombie discussed using psychotherapeutic principles (listening; tolerating hostility) in an eight-session course of small-group discussions for improving the judgements of medical students, in the 1950s. The results supported critical thinking being facilitated by bringing into consciousness *"alternative judgements of the same stimulus pattern"*[81(p172),82]. The students made fewer false inferences, considered alternative solutions, and were less prone to 'mindset' from previous experience. Better clinical judgement was pursued through focusing on process not results, challenging schemata and attitudes affecting perception, confronting students with change in themselves and the world, and harnessing the power of the group[81]:

> *"Discussion in a group does for thinking what testing on real objects does for seeing... Instead of seeing our own mistakes by contrast with the statements of an unquestioned authority as in the traditional pupil-teacher relationship, we see a variety of interpretations of the same stimulus pattern, and the usefulness of each must be tested in its own right."*
>
> Abercrombie, 1960[81(p75)]

As noted by Jacques, small group-work is as much about learning about groups as about skills and concepts[83].

Summary

There are important lessons for the reform of undergraduate medical education from approaches to adult and experiential learning and critical thinking. These include making expectations explicit; valuing prior knowledge and experience; promoting learner readiness and responsibility; balancing process- and outcome-orientations; and using reflection and groupwork for awareness-raising about the more elusive skills.

Chapter 5: Problem-based learning

Higher education curricula are reorientating towards lifelong learning and different notions of knowledge[14]. This chapter explores problem-based learning (PBL), a reform tool favoured by many medical schools world-wide. Margetson noted that undergraduate medical education provides the best examples of PBL and its importance to higher educational reform[16]. In scrutinizing PBL, however, the medical literature tends not to deconstruct inherent notions of knowledge and thinking, and to suffer semantic confusion, especially concerning 'problem-solving'. This chapter covers the:

- origins of PBL, and semantic issues;
- potential and achievements of PBL, particularly related to knowledge;
- uneasy relationship between PBL and problem-solving;
- public health education and PBL.

Origins of problem-based learning

PBL is a recycled idea[84] with an identity crisis but an impressive record of reform in medical schools world-wide. PBL has embodied innovation in professional education in recent decades[13,71], arguably being *the* most important innovation since educational institutions became responsible for this education[13].

PBL was fostered and launched in the North American foundation medical schools of Case Western Reserve University and McMaster University in the 1950s and 1960s, respectively[13]. Barrows developed PBL at McMaster as a vehicle for integrating

knowledge while emphasizing problem-solving skills, because he was unhappy with the impoverished knowledge-base accrued by medical students during his neurology 'clinical clerkship'[58]. He presented it as *a* (not the) major method for undergraduate medical education[58]. Schmidt described Barrows' unique contribution as recognizing the potential for students to use new information from external sources (building on discovery learning, which uses none)[85]. ('Case study' differs in assuming that knowledge must be in place *before* application[85].) Within a decade, many other professions (e.g. nursing[86], engineering[87]) and other medical schools (Newcastle, Australia and Limburg/Maastricht being pioneers) had adopted PBL[13]. Nevertheless, its definition remains elusive[71,88,89].

Like experiential learning, 'PBL' has been used to describe heterogenous educational activities. Even Barrows was unconvinced by people professing to understand his method because they used it likewise[90]. Barrows considered his own PBL to be merely a species in *"a genus for which there are many species and subspecies"*[89(p485)].

The meaning of 'problem-based'...

Various claims are made for PBL concerning gains in knowledge, understanding, and thinking. Indeed, Margetson distinguished between PBL and the more 'traditional' subject-based learning by their different conceptual origins of knowledge, understanding, discovery, and education[91].

Margetson preferred 'problem-*focused*' to 'problem-*based*', but acquiesced to the latter's popularity[16]. He considered problem-*based* to imply foundationalism, i.e. certain knowledge is a prerequisite (foundation) for learning other knowledge[16], as in 'theory before application' curricula exemplified by the preclinical/clinical divide in traditional undergraduate medical curricula. Naive Western notions of foundations, certainty, and separateness of knowledge thwart attempts at educational reform, maintain subject-divisions, and encourage 'either'/'or' pairings of liberal/vocational[92], pure/applied, and theory/practice[16]. Higher education then clings to the former and government to the latter in any pair, both claiming foundational priority[16]. An unhelpful fact/value dichotomy is also encouraged, which:

> *"...masks other vital qualities of educative teaching and learning. Qualities of critical, reflective, imaginative and sensitive thinking do not appear simply to be matters of 'fact', and therefore one seems forced to regard them somehow as matters of value."*
>
> Margetson, 1994[16(p16)]

The word 'problem' also causes difficulties in itself[93], not least because of negative connotations. Barrows and Tamblyn described the PBL 'problem' as an unacceptable situation needing correction, *"an unsettled, puzzling, unsolved issue that needs to be resolved"*[58(p18)]. Dolmans and Schmidt described it as a *"set of phenomena in need of some kind of explanation"*[94(p372)]. Others focused on scenarios, which to be understood, require learning (rather than solutions)[95]. From an international symposium, Walton and Buckley summarized the nature of the PBL 'problem' as:

> *"a set of circumstances in a particular setting which is new to the student, where the use of pattern recognition alone is insufficient, but where specific items of knowledge and understanding have to be applied in a logical analytical process in order to identify the factors involved and their interaction."*
>
> Walton and Matthews, 1989[93(p543)]

While preferring terms like 'learning in a functional context', 'task-dependent learning', and 'problem-generated learning', they accepted that 'PBL' was entrenched. Concerning this label, they quoted Simon (referring to another unwanted label), *"It may be easier to cleanse the term than dispense with it"*[96].

Accepting the 'problem-based' epithet, the interchangeable use of 'PBL' and 'problem-based curriculum' needs comment.

Defining 'problem-based curriculum'

The use of the term PBL ranges from isolated methods for parts of curricula and individual 'subjects' to guiding philosophies for whole curricula, i.e. merging into the 'problem-based curriculum'.

Ross distinguished three overlapping types of problem-focused curricula in terms of process and philosophy[97]:

- problem-based curricula: students work wholly or partly on problems;
- problem-orientated curricula: content and method are selected using problems;
- problem-solving curricula: problem-solving skills are addressed *specifically*, requiring prior knowledge *about* the problem.

Problem-based curricula vary according to the method of selecting problems and identifying resources, purpose and format of problems, and specific processes[97]. As

Ross highlighted, in *"the most significant approach"*(p36) to problem-based curricula, knowledge arises *from* working on a problem rather than, with problem-solving, being a prerequisite *for* working on a problem[97].

Engel summarized the essential characteristics of a problem-based curriculum differently, i.e. that it is[98]:

- cumulative (repeatedly reintroducing material at increasing depth);
- integrated (de-emphasizing separate subjects);
- progressive (developing as students adapt);
- consistent (supporting curricular aims through *all* its facets).

Implicitly, Engel defined a problem-based curriculum as one with PBL as the methodological and philosophical mainstay[98], without emphasizing the role of the 'problem'.

Combining Ross's and Engel's definitions, problem-based curricula can be defined largely philosophically. Firstly, knowledge is acquired, in an active, iterative, and self-directed way, predominantly by working on a progressive framework of problems unconstrained by 'subject' divisions. Secondly, acquiring new subject knowledge is not the starting point for learning. Thirdly, process details may vary but only *within* this philosophy, which should not be undermined by other curricular elements.

Defining 'problem-based learning'

In his explanatory text *for students*, Woods distinguished PBL and subject-based learning[99]:

- *Problem-based learning*: is driven by problems, from which students identify and pursue their own learning needs and then reapply learning to the problem.
- *Subject-based learning*: uses problems to illustrate the application of knowledge *after* students have learned as directed by others.

Subject-based learning is intuitively suspect:

> *"How can subject-based learning be considered efficient in the long run if patients do not present themselves as isolated examples of information from one discipline?"*
>
> Barrows and Tamblyn, 1980[58(p12)]

This raises the question about why Barrows worked on PBL for neurology as opposed to medicine generally! Nevertheless, Woods, a chemical engineering academic at McMaster, acknowledged the *Medical* School's influence on his approach, i.e. focusing on *"self-assessed, self-directed, interdependent, small group PBL"*[99(pix)].

Norman's description of PBL as learning on 'a need to know basis' to address a problem is simplistic but useful:

> *"PBL is simply a case of learning 'stuff' as the students works [his/her] way through a clinical problem... Some of it is the usual stuff of medicine - Krebs cycles [sic] and Starling [sic] Laws [but] the problem is unbounded, and the stuff also encompasses epidemiology, psychology, pharmacology, and just about any other -ology you care to name."*
>
> Norman, 1989[88(p2)]

It is in refining beyond *"learning 'stuff'"* that difficulties arise, and the differing stances on problem-solving are notable in subsequent references to expert views.

Semantic confusion around PBL compromised three contemporaneous systematic reviews of its effectiveness in undergraduate medical education from literature

spanning two decades[71,100,101]. The first two selected literature according to working definitions, and all three emphasized different characteristics:

- Albanese and Mitchell highlighted using problems[71]:
    - before, not after, learning basic concepts;
    - that do not provide or synthesize all the information needed to solve the problem (at least initially);
    - to focus and integrate learning of basic science, clinical knowledge, and clinical reasoning (citing Walton and Matthews[93]).
- Vernon and Blake defined a method of learning focused on using[100]:
    - real or hypothetical clinical cases;
    - small-groupwork;
    - collaborative independent study;
    - hypothetico-deductive reasoning;
    - faculty direction that is about process not imparting information.
- Berkson avoided the semantic debate and described PBL as an alternative to the first two traditional basic science years, using student-led small-groupwork facilitated by tutors (not providing information) to stimulate hypothetico-deductive problem-solving[101].

Boud and Feletti gave a more process-orientated explanation of the main components of PBL[13]:

- Work involves only one problem at a time.
- Stimulus material, usually interdisciplinary, sets context.

- A tutor, usually 'non-expert', facilitates small-groupwork.
- Students are not told how to approach the problem, but resources are available for its clarification.
- Learning objectives are generated and researched by the students.

The explicit complementary assumptions were that students want to solve problems, the curricular core comprises a framework of problems stimulating and focusing learning (replacing exposition of disciplinary knowledge)[13], and learning is reapplied to the problem.

Walton and Matthew synthesized the 'components' of PBL in three categories[93]:

- *essential characteristics* - curricular organization around problems not disciplines; integration of basic and clinical sciences; emphasis on cognitive skills as well as knowledge;
- *facilitating conditions* - small-groupwork; student-centred; active learning; independent study; simulation; problems comprising relevant, high-priority, community-orientated issues;
- *outcomes facilitated* - functional knowledge; motivation; lifelong-learning skills; self-assessment skills.

Clearly, PBL definitions will vary with intended goals and settings. 'True' PBL is synonymous with a 'problem-based curriculum', being a comprehensive curricular strategy and not just a method[93,98]. Worryingly, however, in explaining the term to 'jobbing' doctors (guaranteed to imply that change is off the agenda), Lowry dismissed educational jargon that disguises doctors' every-day educational practice[102]! PBL's

propensity to polarize views will be revisited after summarizing the intentions and achievements of PBL.

Potential and realized goals and outcomes of problem-based learning

The evidence concerning PBL is undermined by the diverse definitions and goals in use. Norman and Schmidt highlighted the irony of medicine, grounded in scientific method, supporting PBL so strongly when, from evaluation evidence, differences in process and outcome favouring PBL over traditional approaches are small at whole-curriculum level[84].

From cognitive psychology, Norman and Schmidt distilled three (as yet unsubstantiated) roles for PBL from research on i) memory; ii) problem-solving and case-based reasoning; and iii) the 'instance' theory, concept formation and categorization, respectively, i.e. acquiring[84]:

- *factual knowledge in context*: activating prior knowledge; elaborating knowledge (discussion; notetaking); matching context for recall;
- *principles transferable to other problem-solving*: via two prerequisites: i) learners knowing little of the domain of the solution or underlying principle (no 'advance organizers'; insufficient 'prior knowledge' for initial understanding); ii) immediate feedback after working through the problem;
- *prior examples*: by accumulating many 'instances' for use in future practice.

Engel attributed two purposes to PBL driving a curriculum, i.e. as[98]:

- *method:* achieving capability in generalizable competences (e.g. dealing with change and problems, reasoning critically and creatively, practising holistically and empathetically, collaborating in teams, self-directed learning).
- *philosophy:* providing adult learning conditions, for cognitive *and* affective elements, by being active, integrated, cumulative, and for 'understanding'.

Barrows gave the main objectives of PBL as[89]:

- structuring of knowledge in clinical contexts;
- clinical reasoning;
- self-directed learning skills;
- intrinsic motivation.

Barrows then devised a 'PBL' taxonomy[89], really a collection of educational approaches sharing 'use of problems' (**Box 2**). *Barrows'* objectives are progressively (and conveniently) fulfilled by moving through *Barrows'* taxonomy. Only the highest level, 'reiterative or closed-loop' PBL, potentially fulfils all objectives[89].

Box 2: Barrows' 'taxonomy of problem-based learning'

- **lecture-based cases:**
  Cases are used to demonstrate relevance of information provided by lecture.
- **case-based lectures:**
  Cases highlight material to be covered in the subsequent lecture.
- **case method:**
  Cases are studied in preparation for class discussion, a traditional approach in law and business education.
- **modified case-based:**
  Cases provide opportunities for deciding between a limited number of options for action (clinical enquiry and/or clinical intervention).
- **problem-based:**
  Cases are used in a problem simulation format encouraging *free* enquiry.
- **closed-loop or reiterative problem-based**
  A reflective phase complements the problem simulation format.

Source: **adapted from Barrows, 1986**[89]

Barrows' taxonomy drew useful distinctions in a confused field, but is hardly a taxonomy of 'PBL' when 'true' PBL comprises only one of six levels. Ross concurred, casting Barrows' taxonomy as a self-fulfilling analysis because it justifies PBL's supremacy using Barrows' own objectives[97]:

> *"...as much a taxonomy of teaching-learning methods, within which problem-based learning fits, as it is of problem-based learning itself."*
>
> Ross, 1991[97(p38)]

The previously mentioned systematic reviews of PBL versus traditional approaches were cautiously optimistic about its performance but hindered by different definitions and study designs in two decades-worth of literature[71,100,101]:

- In their meta-analysis-type review, Albanese and Mitchell[71] found PBL to be more nurturing and enjoyable, with graduates performing similarly if not better than traditional counterparts and tending more towards family medicine. Some concerns were raised over basic science content coverage and related 'cognitive scaffolding' (but the flawed evidence-base precluded firm conclusions); and possible overdependence on small-groupworking.
- Vernon and Blake's[100] meta-analysis was even more supportive of PBL, with students' programme evaluation, attitudes, attendance, mood, and clinical performance being consistently more positive, and unsupportive of knowledge deficiencies.
- Berkson[101] concluded that PBL curricula are unlikely to *surpass* traditional curricula in imparting 'problem-solving', imparting knowledge, enhancing motivation, improving self-directed learning, or providing happier experiences.

> Higher resource use and failure to meet such unrealistic expectations were forgiven, however, because of PBL's explicit commitment to students and to educational principles while producing competent graduates.

While more robust evidence is needed[103], PBL has survived unprecedented scrutiny in undergraduate medical education.

Problem-based learning as a tool of epistemological reform

Margetson considered PBL to be a tool of reform at many levels[16]. PBL, for example, potentially redresses the 'triple-bind' in higher education in Australia, New Zealand, and United Kingdom of:

> *"...self-defeating government educational reform policy, unconvincing grounds for resistance to reform in higher education, and a mainly hostile relation between the two parties inhibiting serious dialogue and effective cooperation."*
>
> Margetson, 1994[16(p9)]

PBL also potentially fulfils Biggs' four crucial criteria for a deep approach to learning, i.e. a well-structured knowledge-base, learner activity, learner interaction, and motivational context[16]. PBL also prepares professionals to tolerate uncertainty and work with probabilities[93].

Boud and Feletti commended PBL's harmony with adult learning theory, emphasis on acquiring learning skills (not the impossible, evergrowing knowledge-base), high face validity, responsiveness to changing professional practice, and flexibility[13]. PBL embodies 'andragogy', in helping learners to learn actively using process- rather than

content-orientated approaches, thus addressing core criticisms of traditional approaches.

PBL aims for efficient acquisition and restructuring of knowledge (e.g. demonstrating relevance in context, and fostering 'semantic networks' and internal motivation/'epistemic curiosity'[104]). Two features of PBL, i.e. prior knowledge and metacognition, are those highlighted by Halpern as important for efficient learning (together with subsequent knowledge, stereotypes, and meaningfulness of material). Halpern emphasized the centrality of activating prior knowledge for efficient learning, i.e. *"We build on the knowledge created by others to create new knowledge"*[44(p5)]. Halpern was also less disturbed by lack of knowledge in students than by students not knowing that they do not know (e.g. betraying superficial understanding by scattering 'labels' and jargon rather than concepts into discussion)[44].

Problem-based undergraduate medical curricula have had a turbulent reception related to their knowledge perspective. They are not afforded the 'automatic legitimacy' of their traditional counterparts. Even new problem-based medical schools (which should encounter less resistance than traditional medical schools[105] undergoing comprehensive conversion, e.g. Sherbrooke[106]; Hawaii[107]) can slip backwards towards classical didactic teaching when early pioneers leave[108]. Public assurances of support for PBL can prove less forthcoming in practice[109]. Glick likened PBL to 'experimental' new drugs that receive overenthusiastic early reports until side-effects supervene[110], a rather harsh critique given its decades of history and more considered educational foundations than traditional approaches:

> *"Problem-based learning is not a mere method to be taken up and discarded as just another passing fashion."*
>
> Engel, 1991[98(p31)]

Woods described a grieving process expected from changing to PBL[99]. Margetson questioned the *"remarkably strong, even vehement, reactions... [and] a surge of passionate hostility"*[91(p42)] to PBL from staff. Explanations included the perceived association of PBL with PBL evangelism, intangible outcomes, new work patterns, and change generally. Most blame, however, was focused on inadequate conceptions of expertise, knowledge, teaching, and learning in education, grounded in the separationist view of scientific discovery highlighting products over the enquiry process. According to Margetson, teachers adopting these inadequate views uncritically and unreflectively show deep, albeit misplaced antagonism when challenged explicitly by PBL[91].

PBL is dogged by controversy concerning its relationship to knowledge, and its relationship to problem-solving is no less challenging.

Problem-solving and problem-based learning

The hypothetico-deductive model of clinical reasoning[111,112], as championed by Barrows for medical students[113], has been used to advocate 'serial questioning-justification-interpretation' educational approaches[114], but needed adapting to address criticism[115,116]. The potential for PBL to develop such problem-solving[58,89] has also been doubted[88,95]. The semi-isolated medical literature attributes the hypothetico-deductive model of systematic hypothesis generation (guided by

probability, seriousness, treatability, novelty[117]) and hypothesis testing to Elstein *et al*'s empirical work on clinicians' reasoning strategies to reduce uncertainty[117,118]. It was used to counter the *"progressive constraint-seeking inquiry strategy generally taught by medical schools"*[117(p91)], but even Elstein has now admitted the model's *"vicissitudes"*[116(p121)]. The debate on clinical judgement resurfaces, dependent as the model is on clinical experience, problem complexity, and setting.

The empirical evidence[115,116,119] suggests that clinical experts use *forward reasoning* (i.e. from data to diagnosis)[120] with familiar problems, thus matching the current case by 'pattern recognition' with previous cases and retrieving the relevant knowledge. The *backward reasoning* hypothetico-deductive model (i.e. from possible diagnosis to expected data) involves working backwards from a hypothesis to find confirmatory or falsifying data. This more time-consuming approach is used by novices, but experts resort to it when outside their expertise or with complex problems or settings. Indeed, Norman *et al* showed that, compared with novices, when diagnosing complex cases, clinical experts mix forward and backward reasoning, generate multiple hypotheses, rely more on scientific principles, and 'chunk' data around these[115]. Experts' experience[121] and quality of diagnostic hypotheses characterizes their problem-solving ability[111], with efficient retrieval and processing of content-knowledge being crucial:

> *"...we have [not] identified general, problem-independent strategies related to expertise. Rather... the result of an expert's comprehensive knowledge base is a judicious and comprehensive choice of alternative diagnoses and a highly efficient search for additional data to use in ruling in or out competitors."*
>
> *"To observe expert problem-solving, it is essential to place the expert in a setting in which the routinized shortcuts will fail."*
>
> Norman, Trott, Brooks *et al* 1994**115(p119, 120)**

The role of PBL in facilitating clinical problem-solving also has its vicissitudes. Norman challenged the *"from carpentry to cardiology"***95(p279)** assumptions about problem-solving skills, doubting their existence in this 'quixotic' search (if skills were general strategies, applicable in various situations, and independent of specific situational knowledge)**88,95**. Norman also considered that:

> *"[PBL] as an instructional strategy is unrelated to the learning of problem solving skills... the majority of problems in clinical medicine are solved through mental strategies that do not fit into the conventional definition of 'problem solving skills'."*
>
> *"It is unlikely that the process of working through the problem adds to any repertoire of general problem-solving skills."*
>
> Norman, 1988**95(p279, 283)**
>
> *"The expert is an expert primarily because he has seen it all before."*
>
> Norman, 1989**88(p2)**

Supporting this, Berkson found no evidence for problem-solving skills being acquired better in problem-based rather than traditional curricula**101** She concluded that problem-solving skills and their communication develop serendipitously in such curricula**101**. Norman found it ironic that PBL might emerge as the way to learn problem-solving, but for the 'wrong reasons', i.e. not by affecting the problem-solving process per se but making knowledge more accessible to it**111**. PBL has been used to

address problem-solving skills specifically with new medical students[122], but this is unusual.

Conceptual and technical difficulties with problem-solving are compounded by terminology. Berkson admitted that prevailing definitions are inadequate guides to develop tools for measuring let alone teaching problem-solving[101]. Semantic discomfort relating 'problem-solving' to clinical practice or PBL is not, however, exclusive to medicine. Describing an undergraduate agricultural curricular review to introduce experiential learning, for example, Packham *et al* preferred the term 'situation improver' to 'problem-solver', emphasizing that single solutions do not characterize complex projects[123].

Problem-based learning and public health education

PBL is a potentially useful vehicle for public health education of both staff and students. As highlighted by White and Connelly, medical faculties are in danger of reneging on their 'social contracts' with their 'populations'[32], fuelled by faculty not considering wider determinants of health and exposing medical students to unrepresentative health experiences[124]. Community-orientated medical schools such as at Beer Sheva (Israel), which merged education and care provision to produce primary care-orientated doctors and improve local health and health care through an explicit social contract, are rare[125]. Concerning American students, Riegelman diagnosed Medical Student Myopia Syndrome (inherent antipathy towards 'preventive medicine and epidemiology') and recommended *"RICE therapy (relevant, innovative,*

clinical with exacting expectations)"[126]. Public health education needs the context-setting and motivating powers of PBL to demonstrate relevance and broaden perspectives.

Glick suggested that PBL might compromise community-orientated medical education and public health education, by encouraging reactive practice (to presenting 'problems') not proactive practice (in seeking and preventing problems)[110], but public health academics have been cautiously optimistic[127]. The potential benefits of PBL to public health education are apparently peripheral to the main concerns of the literature. Semantic, conceptual, philosophical, and historical differences about public health internationally[26,128,129] render the development of public health education with PBL difficult to trace. Reports on separate PBL *courses* for public health, e.g. within a 7-week Health, Society & the Physician course at Dartmouth (New Hampshire)[130], or Harvard's integration of 'health promotion and disease prevention' into several major courses[131], are useful but not central to this discourse. It is encouraging, however, that, in the public health part of national examinations, the Harvard PBL students outperformed their traditional counterparts[131].

Summary

PBL is an educational method *and* philosophy, a tool of epistemological reform. It is surrounded by semantic confusion. It should not be assumed that learning problem-solving is central to PBL. Public health education has been relatively ignored in reports of the development of PBL.

Chapter 6: Problem-based undergraduate medical curricula

Having explored the nature of problem-based learning (PBL), and before highlighting the PBL tutor, this chapter outlines issues of practical curricular interest relating to:

- problem-based undergraduate medical curricula world-wide, generally;
- the pioneering innovative curricula from the medical schools of: McMaster (Canada), Maastricht (Holland), Newcastle (Australia), launched 1966, 1978, and 1978, respectively;
- Liverpool's 'new' curriculum, launched 1996[132].

Problem-based learning in undergraduate medical curricula generally

Following McMaster's example, PBL has been variously adopted by many medical schools world-wide usually integrating basic and clinical sciences. Indeed, for 1992-93, Vernon identified 27 relevant North American curricula, of which 14 (including 8 'twin-tracked') were uniformly problem-based (**Box 3**)[133].

Box 3: Undergraduate medical curricula using problem-based learning (PBL) in North America (1992-93), n=27, as identified by Vernon's survey of all PBL tutors

- 6 uniform problem-based curricula (Dalhousie, Harvard, McMaster, Mercer, Ottawa, Toronto);
- 8 uniform problem-based curricular tracks (run separately from, but parallel to traditional tracks);
- 5 non-departmental PBL courses within traditional curricula;
- 3 departmental PBL courses within traditional curricula;
- 4 non-participating schools (no further details);
- 1 respondent with *"the nature of its PBL program [too] ambiguous"*(p217) to include.

Source: **adapted from Vernon, 1995**[133]

The pioneering medical schools (McMaster, Maastricht, Newcastle) were launched as 'problem-based' medical schools, whereas traditional medical schools face many pitfalls (e.g. resistance[105], resourcing[101]) in comprehensively converting to PBL. This was illustrated by the aborted attempt to convert Otago medical school (New Zealand), described by Schwartz *et* al[134,135].

The Harvard conversion was 'two-staged', the problem-based New Pathway 'twin-tracking' with its traditional counterpart until complete conversion was possible[136]. From this experience, Moore recommended a 'do it and fix it' approach to such curricular implementation[136]. Two traditional medical schools reporting successful 'one-step' transformations to problem-based curricula were Sherbrooke (Canada) [106,137,138,139] and Hawaii (United States)[107,140]. Staff development strategies were important contributors to their successful implementation. Closer to Liverpool, Manchester was the first British curriculum to undergo comprehensive transformation (1994), but it retained a clinical/preclinical divide[141,142].

McMaster, Maastricht, & Newcastle undergraduate medical curricula

Neufeld and Barrows summarized the McMaster philosophy as promoting self-directed learning, problem-based learning, small-group learning, integrated learning, good use of learning resources, and formative evaluation[143]. Immediate clinical contact was also a feature[11]. Controversially, tutorial-based group-assessment and self-assessment were used rather than written examinations and grades. Nevertheless, student

assessment anxiety prevailed[11] and, by 1991, given concerns about graduate performance, Maastricht-type 'progress testing' was introduced[144].

In Maastricht, students elect 'chairs' and 'scribes' to assist PBL tutorial progress through 'seven steps', based on the hypothetico-deductive model (**Box 4**)[145,146,147,148]. Another original feature was the quarterly 'Progress Test'. The same broadly-based 'true/false/unsure-format' test was taken simultaneously by all 'years', discouraging revision and allowing students to monitor personal progress.

Box 4: The Maastricht Seven Steps for problem-based learning

1. clarify and agree working definitions of unclear terms/concepts;
2. define the problem(s), agreeing which phenomena require explanation;
3. analyse components, implications, suggested explanations (through 'brainstorming'), developing working hypotheses;
4. discuss, evaluate, arrange the possible explanations/working hypotheses;
5. generate and prioritize learning objectives;
6. go away and research these objectives between tutorials;
7. report back to the next tutorial, synthesizing a comprehensive explanation of 'the phenomena', reapplying synthesized newly acquired information to the problem(s).

Source: **adapted from Foster & Gilbert, 1991 (after Schmidt & Bouhuijs, 1980)**[145]

The Newcastle curriculum has five domains acting as curricular pillars and guiding delivery and assessment (**Box 5**)[149]. Henry highlighted Newcastle's use of PBL for first and second years as *one* of several very important components (including small-groupwork, integration, community-orientation, early clinical context), but not the main focus:- *"...poor doctors are not a disease of problem-based learning deficiency"*[149(p8)]. Interestingly, Newcastle's PBL was transformed in 1985 to replace 'problem-*solving*' terminology/philosophy with 'clinical *reasoning*', McPherson

invoking Barrows and Tamblyn, the 'hypothetico-deductive model'[58], and refocusing on processes rather than solutions as the rationale[150]!

Liverpool undergraduate medical curriculum

Liverpool Medical School was established in 1834, and revised its undergraduate medical curriculum in time for its 1996 intake! (*Tomorrow's Doctors*[1] arrived at an opportune time (**Chapter 2**).) This 'new' curriculum fulfils Friedman *et al*'s criteria for an innovative undergraduate medical curriculum[151] by having a *curriculum-wide*, overall, explicit guiding *philosophy*, and educating *all medical students* in the relevant cohorts in a very *'non-traditional'* way. Given such innovation and change, major efforts were focused on staff development, particularly in PBL tutoring, e.g. training visits for key staff to McMaster[152] (and/or Maastricht[153]), many of whom went on to be PBL tutors in the first-ever Year 1. As described by Evans and Taylor[154], volunteer tutors then engaged in PBL to learn about PBL (also described by Wilkerson and Hundert for Harvard tutor development[155,156]). One-hour monthly tutor development meetings were introduced to maintain momentum.

Box 5: The domains and themes guiding the Newcastle (Australia) and Liverpool (England) problem-based undergraduate medical curricula

Newcastle	Liverpool ('core curriculum')
Domains: • Professional Skills • Clinical Reasoning • Identification, Prevention & Management of Illness • Population Medicine • Self-directed Learning	Themes guiding problem-based learning: • Structure & Function in Health & Disease • Individuals, Groups & Society • Population Perspective • Professional Values & Personal Growth[157] Other complementary elements: • Clinical Skills • Communication Skills[158]

Source: **adapted from Henry, 1997 [149], and Faculty of Medicine, The University of Liverpool, 1996 [159]**

The PBL tutorial[160] is the 'core curricular building block' and one of few *compulsory* elements (including clinical and communication skills sessions). The Liverpool PBL approach will evolve. In the foundation year, there were three 1½ hour PBL tutorials per 2-week 'module' (e.g. *Travellers' Health* (**Box 6**); *Indigestion*), two for occasional 1-week modules. The Maastricht Seven Steps, with elected chair and scribes, were *recommended*[161]. Paper case scenario(s) were designed to trigger an indicative set of faculty objectives across four curricular themes (**Boxes 5 & 6**). Tutors (but not students) received faculty objectives to inform their group facilitation. Student-generated learning objectives were collated to inform the design of formative and summative student assessments.

Box 6: *Year 1, Semester 1, Liverpool undergraduate medical curriculum 1996/97* - 'Travellers' Health' problem-based learning (PBL) module case scenarios

- Tutorial 1:- Students generate their own learning objectives about:

  "A young couple, who have two children aged 2 and 6 years, win the National Lottery and book their dream holiday - an African safari. Two weeks before their departure, the father reads in the Sunday newspaper about the problem of cholera in the third world. The mechanism by which the lining of the small intestine is affected is described in detail. They decide to see their general practitioner."

- Tutorial 2:- Students while checking on progress with their learning objectives are refining and/or generating more (given the unfolding nature of the case scenario):

  "The whole family is having the time of its life on safari, although after 7 days in the bush they are all a little bit the worse for wear because of sunburn and mosquito bites. Then the 2-year-old gets watery diarrhoea and the mother insists that the tour guide takes them to the nearest city hospital to get some antibiotics. The guide reassures them that this is unnecessary and that the sachets of Dioralyte in the First Aid box are all that is needed."

Source: **Faculty of Medicine: Undergraduate medical curriculum - tutor guidance materials. Liverpool: The University of Liverpool, 1996/97.** [with permission - Faculty of Medicine]

In six Semester 1 modules (21 tutorials), the same 32 groups of 6-7 were facilitated by the same PBL tutors. Group learning objectives were identified in Tutorial 1, for self-study by *all* students (supported by directed learning materials). 'Lectures' were replaced by once-daily non-compulsory 'plenary sessions' meant to cover, for example, material not easily accessible from other sources. Students discussed progress in Tutorial 2, refining and/or generating new learning objectives. In Tutorial 3 new learning was again synthesized and applied back to the case scenario(s). Each time, end-of-tutorial evaluation was for student-tutor reflection on group process.

Summary

Liverpool's 'new' problem-based undergraduate medical curriculum has drawn on experience from around the world. PBL tutors are a key figure in the students' experience.

Chapter 7: Problem-based learning tutors

This chapter highlights the problem-based learning (PBL) tutor, a rarer target of the PBL literature[151] than students and curricula. In his explanatory text for students about PBL, for example, Woods understandably referred sparingly to the role of the tutor[99], but there is danger in assuming that 'student-centred' means 'tutor-inactive'.

The main topics outlined here, focusing on undergraduate medical curricula, are the:

- tutor-student roles and relationship;
- effect of content expertise on tutor role;
- tutors' conceptualizations of this role (according to previous work), and the design context for an empirical study.

The tutor-student roles and relationship in problem-based learning

Barrows and Tamblyn conceptualized the PBL tutor as an expert in group facilitation rather than content[58] (complemented by Ross's dislike of the label 'tutorials' for sessions supposedly resembling professional planning/strategy meetings[97]). In PBL, such facilitation is:

> *"essentially by questioning, probing, encouraging critical reflection, suggesting and challenging in helpful ways - but **only** where necessary."*
>
> Margetson, 1994[16(p10)]

Brookfield advised 'facilitators' generally against vain attempts to emulate perfection[47], and against implying that students can achieve *anything* through commitment[162]. Brookfield preferred to balance *"the dark side of self-actualization"* with much of *"the rhetoric about self-direction"*[162(p22)].

The PBL tutor is therefore PBL group process custodian[163] and 'guide for discovery'[143] rather than information-dispensing model of perfection or overenthusiastic educational cheerleader. This core task of ensuring satisfactory progress through the problem[16] revolves around tutor intervention dynamics, i.e. deciding when and how to intervene.

Woods outlined to students McMaster-type question-based interventions, i.e. to ensure[99]:

- understanding and appropriateness of approach;
- reflection on ideas raised and justification of conclusions from evidence.

A third should be added, i.e. to ensure tutor-student reflection on group process.

Woods also explained expectations on students[99], using Perry's model of learning[164], advising a move to Perry's Level 5 attitudes from 2-4 for PBL (**Box 7**).

Box 7: An extract from Woods' representation of Perry's model of attitudes towards learning (incorporating seven attitudes scored 1-5)

	Level: 1-2	⇒ **5**
• knowledge	*All knowledge is known.*	⇒ *Different knowledge is needed in different contexts.*
• answers to problems	*Either right or wrong.*	⇒ *No absolute truth; answers are relative but good answers exist once the conditions are known.*
• teacher, tutor, instructor	*Instructor and books know the truth.*	⇒ *Role is to be a guide and source of expertise.*
• student's role	*To receive.*	⇒ *To identify the conditions; to choose the best ideas.*
• assessment	*Worried if exam format is fuzzy. Asks, "What do you expect?" Equate bad grades with bad person.*	⇒ *Seek positive and negative feedback on assessment.*
• preferred task	*Memorize definitions.*	⇒ *Synthesis. Relate ideas between contexts.*
• difficult task	*Decide which of two conflicting authorities is correct. Tell me.*	⇒ *Decide on which conditions apply.*

Source: **adapted from Woods, 1994 99(p1.6) (after Perry, 1970 164)**

The PBL tutor-student relationship narrows the intellectual distance between them to that of colleagues[130] (with tutors ideally as role models for self-directed learning[143]), but potentially tutors feel threatened. Authority is exercised differently *not* abandoned in PBL. Tutors become uncomfortable through confusing authority with authoritarianism[16]:

> *"In problem-focused education [authoritarian attitudes] are particularly out of place since it is a participative, co-operative, reflective, critical, and informed educational practice. This requires a radically changed attitude towards students; they are regarded more as colleagues who are novices... [rather] than appropriate recipients of the paternalistic attitudes which are often the norm."*
>
> Margetson, 1994[16(p11)]

Evidence from Maastricht (a questionnaire survey of first to fourth year medical students) suggested that PBL tutors have an unchanging influence on students' drive

to learn with progress through the curriculum, despite evidence for increased self-directed learning[94].

Problem-based learning tutor development

> *"Only as teachers in schools free themselves from their traditional teacher tasks - boss, cop, judge - will they will be able to learn enough about their students to see how best to be of use to them."*
>
> Holt, 1982[38(p36)]

Staff development is central to comprehensive curricular conversion from traditional to problem-based philosophy[138,154]. Tutors used to didactic teaching need reconditioning, particularly away from 'information-dispensing'[165].

Experiential learning and groupwork are particularly relevant to tutor development:

- *Firstly*, an *"uncomfortable journey back to ignorance"*[166(p59)] helps tutors' self-improvement[162,166]. Brookfield considered that tutors empathize better with learners' emotional struggles by regularly becoming learners themselves[162]. Perhaps foundation PBL tutors should particularly empathize with their students, given their own struggle to relearn 'teaching'. Like all facilitators of critical thinking, PBL tutors will resemble *"psychological demolition experts"*[47(p30)], therefore requiring training and sensitivity to encourage learners to retain self-esteem while challenging their own assumptions. Woods advised students to expect to get upset around week 3-4 of PBL[99]!
- *Secondly*, Silver and Wilkerson considered some problem-based curricula to squander the potential for so-called 'collaborative learning'[167] (i.e.

cooperation in common enquiry for students, faculty, and administrators rather than 'groupthink'[168]). Potential disruption of group process[169] by tutors is sometimes ignored. Indeed, much PBL literature does not refer to groupwork literature generally, or recognize PBL tutors (like PBL) as a re-invention from established ideas.

Staff development also needs to consider the meaning of tutor 'expertise'.

Content-expertise and the problem-based learning tutor

> *"No educational effort is entirely free from the underlying values of and assumptions of the facilitator."*[47]
>
> Brookfield, 1987

The effect of PBL tutors' content-expertise is under-researched, and available evidence about group functioning and student achievement is contradictory. Study designs and definitions of 'PBL' and 'content-expertise' differ (e.g. expert according to self- or researcher-rating; level at which rating applied:- for single or grouped problems, or within-problem topics; medical qualifications; discipline; status:- academic, non-academic, student tutors).

Silver and Wilkerson, for example, used tutors' self-ratings of expertise for each substantial topic discussed in PBL sessions. They studied audiotaped sessions from four randomly selected first-time tutors (for two sessions each), in an 11-week interdisciplinary PBL 'course' in pathology, immunology, and microbiology for first year Harvard medical students. Topic 'experts'[167]:

- were more directive;

- spoke more often and for longer (for 42% of group dialogue; 31% for non-experts);
- provided more direct answers;
- suggested more discussion topics;
- presided over predominantly 'tutor-to-student exchange' versus 'student-student exchange' patterns; but
- posed the same proportion of comments as questions (approximately one-quarter).

Despite this study being small, it supported continuing faculty development to raise awareness about the *potential* effects of tutors' authority and knowledge. Silver and Wilkerson were concerned about students missing learning opportunities in prioritizing learning needs, asking and answering crucial questions, and synthesizing[167]. Wilkerson *et al* in a Harvard case study of four PBL groups also found that tutors successfully facilitating self-directed learning were those encouraging active listening, tolerance of silence, and only appropriate interruptions[170].

Eagle *et al* in Calgary Medical School defined expert PBL tutors as the 'problem authors' and/or those encountering such patients in everyday practice[171]. Student-completed questionnaires were received for 35/43 simulated-patient 'case encounters'. Students with expert tutors generated significantly more (twice as many) learning issues (significantly more congruent with faculty objectives), and spent longer studying them. Eagle *et al* recommended that non-expert tutors clarify course goals and case objectives, study the clinical problem, and talk to other tutors experienced with the

case and others with relevant expertise[171]. Davis *et al* also found better student assessment outcomes with content-expert PBL tutors (defined by disciplinary and/or research expertise), but in an isolated PBL 'course' within a traditional curriculum[172].

Having themselves previously found no effects of content-expertise (defined as being medically qualified), Schmidt *et al* reviewed the evidence. The results were inconclusive, hampered by inconsistent definitions, small and flawed studies, and the extent to which tutors were 'warned off' intervention[173]. They then studied student assessment outcomes, and student ratings of self-study time and tutors' behaviour in 336 PBL groups from seven Maastricht health sciences programmes. Process-facilitation skills *and* content-expertise (defined by discipline, e.g. gynaecologists for any problems within a 'gynaecology unit') were found necessary for effective tutoring. (This interesting result is, however, of less value to curricula without disciplinary boundaries!):

> *"Facilitating the learning process of students cannot simply be a matter of knowing how to ask questions; a tutor also needs to know* ***what*** *to ask."*
>
> Schmidt *et al*, 1993[173(p790)]

Subsequent research modelled two prerequisites for the effective PBL tutor:- personal qualities (social congruence with students, i.e. informality and empathy) and subject-knowledge[174]. Such knowledge helped students most[175] when curricula were too poorly structured for the students' level[176].

Studying problem-based learning tutors' conceptualizations of the role

Studies highlighting PBL tutors' opinions about curricular transformation and PBL are *unusual*[151,177], and predominantly questionnaire-based. PBL tutors generally favour PBL over traditional approaches[71] concerning personal satisfaction, and students' interest, reasoning, and clinical preparation[133,178], but competing commitments and suppression of 'content-expertise' frustrate some[101] and foundation tutors worry about when/how to 'intervene'[177]. Lucero et al (New Mexico) reported *in passing* on 'informal interviews' with PBL tutors positively supporting PBL[179].

Tutors' conceptualizations of PBL are, however, *rarely* studied. Two studies focused on foundation tutors:

- In 1991, Abdulrazzaq and Qayed reported on a semi-structured interview study of the characteristics and motivation of all 18 foundation faculty soon after recruitment to the new United Arab Emirates problem-based medical school[108]. Five were hostile to PBL philosophy and five unimpressed[108].
- Wilkerson and Maxwell's semi-structured interview study of 27/31 PBL tutors in the first two years of Harvard Medical School's New Pathway curriculum found early tutors volunteering mostly out of interest in education (89%), reform, and colleagueship[180].

The foundation PBL tutor's 'mindset' is therefore a valuable focus for educational research, especially for a foundation PBL tutor living the experience! Of personal and faculty interest in Liverpool is the research question noted in **Chapter 1 (Box 8)**.

Accepting 'received wisdom' uncritically is counterintuitive, and its application to Liverpool's 'new' problem-based undergraduate medical curriculum merited exploration.

Box 8: Study of conceptualizations of problem-based learning (PBL) by tutors in an undergraduate medical curriculum

- **Research question:**
  Compared with 'received wisdom', what spectrum of PBL concepts prevails amongst foundation PBL tutors in a problem-based undergraduate medical curriculum, and what are the educational (including the public health educational) implications?
- **Study aim:**
  To explore the way that foundation PBL tutors conceptualized PBL, problem-solving, the curricular themes, and their interrelationship (including reference to public health education).

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Pragmatically, this research question could not be comprehensively covered within the proposed study period. Being overambitious in such a distracting phase of change was inadvisable. The semantic and conceptual difficulties surrounding PBL fuelled the investigation, complemented by related issues in problem-solving and public health education (conveniently disguised under 'the curricular themes', avoiding explicit disciplinary boundaries).

The four sets of assumptions describing social reality[181], from objectivity to subjectivity, each occupy a flexible spectrum (**Box 9**) and need not force irrevocable dichotomous choices about research approach.

Box 9: Burrell and Morgan's dimensions distinguishing assumptions underlying 'objective' and 'subjective' approaches to social science

'subjective'	*'objective'*
ontology	
nominalism↔realism;	
epistemology	
anti-positivism↔positivism;	
human nature	
voluntarism↔determinism;	
methods	
idiographic↔nomothetic.	

Source: **adapted from Burrell and Morgan, 1979**[181(p9)]

Data were needed that accessed PBL tutors' perceptions of mission and context by:

- asking tutors directly;
- asking 'second-hand' (indirectly, from students, which is an unlikely proxy; students also being there to learn, not to observe the tutor[174]);
- observing or recording tutors' related actions.

'Gold-standard' triangulation of evidence from several data sources was not feasible within resource, practical, and ethical constraints, and a single-track study design was chosen. The originality and newness of this curriculum and dearth of relevant evidence favoured a 'qualitative'-type approach.

Bogdan and Biklen considered 'qualitative research' to be 'scientific research' if it is rigorous and systematic empirical data-based enquiry[182]. They did *not* consider it an 'all-or-none' label but, with the goal of understanding human behaviour and experience better, on a spectrum to the degree that it fulfils five criteria:

- having the researcher as the key instrument, and the natural setting as the source of data (to prevent words being divorced from context);
- being descriptive (not reducing narrative to numbers);
- being process- rather than merely product-orientated;
- analysing data inductively;
- being concerned with meaning.

Given that 'generalizability' is highly valued in a medical school, a 'robust' design was needed (with some potential for quantification to facilitate appropriate feedback to participants afterwards). Understandable staff-tutor anxieties about the curriculum (particularly about some administrative aspects) and the workload on early volunteers begged an unobtrusive method targeted at individuals. This dismissed focus groups, which also work better when participants and researcher are all unfamiliar with each other[183]. Semi-structured interviews by telephone were chosen, balancing convenience and greater flexibility to tutors (and researcher) both on- and off-campus with loss of face-to-face contact.

Summary

The PBL tutor walks a tightrope of intervention in PBL group process, balancing personal knowledge with social congruence (with major implications for recruitment, reward[108], and quality assurance[184] policies to support PBL philosophy). There is, however, little relevant empirical literature about a major element in the group interaction, the (foundation) PBL tutors' conceptualizations of PBL. The first cohort

of PBL tutors in Liverpool's problem-based undergraduate medical curriculum provided an opportunity and a challenge!

Chapter 8: Methods

This chapter describes the methods of studying the problem-based learning (PBL) tutors, outlining issues related to:

- study subjects, setting, and design;
- data collection and analysis.

The sampling frame comprised the first-ever cohort of PBL tutors (according to Faculty of Medicine records) in the problem-based undergraduate medical curriculum at The University of Liverpool. All tutors responsible for tutoring a Year 1 group for all or part of Semester 1 (October 1996-January 1997), except GM, were eligible and included (N=34). The support of the Chief Tutor, Director of Medical Studies, and Professor of Medical Education was obtained, all being informed of the nature of the study, informally, in conversation, and, formally, in writing. All aspects of this study (e.g. administration, interviewing, transcription, analysis, etc.) were undertaken by GM.

A semi-structured interview schedule was constructed for use over the telephone (**Appendix 1**). A brief scripted opening paragraph about the interview led into open-ended questions. These explored the tutor's conceptualization of:

- problem-based learning,
- problem-solving,
- the curricular themes.

Several closed- and open-ended questions covering personal details, background, and experience were placed at the end. Minor amendments were made to the interview schedule after two interviews.

From February 1997 onwards, the tutors received a letter (sent in batches to deal with responses most efficiently), outlining the study and giving reassurance about confidentiality (**Appendix 2**). Respondents were encouraged to indicate their participation by recording suitable interview times on the enclosed reply-slip (**Appendix 3**), and returning it signed in the enclosed internal envelope or stamped-addressed envelope (for those on- or off-campus, respectively). Reminder letters were sent to non-respondents a month later.

A telephone call was booked with each respondent (34/34; 100% response rate), provisionally for 20 minutes, from 1 day to 3 weeks in advance, either by preliminary telephone call, in writing, or in person (opportunistically, on-campus). These brief communications helped to clarify queries raised by respondents.

All interviews were carried out during Semester 2, between February and June 1997. Those tutors continuing as PBL tutors, according to the Faculty of Medicine records, were interviewed ahead of their first Semester 2 tutorial.

The interview schedule guided the interview. Introductory comments were made according to the scripted paragraph. Permission was sought to record the interview, explaining that the audiocassette was erased after supplementing written interview notes. A device connecting the telephone earpiece to a dictation voice-recorder was

then used to record the core of the interview. Prompts were used and clarification of responses was sought, as appropriate. Questions were clarified as requested by interviewees. The brief contemporaneous written notes were used, for example, to summarize interviewees' explanations of 'problem-based learning' for interviewees ahead of the next question and, similarly, as a reminder in the problem-solving section (Question 2c, **Appendix 1**). Full answers were encouraged. Any solicited discussion of the views of the interviewer or other interviewees was deferred until the interview was completed. (The median duration of interviews was 20 minutes; range 15-60 minutes.)

After the interview, the written notes were supplemented from the tape-recording, producing a verbatim copy of the major issues in the responses and paraphrasing repeated or connecting discourse. Each completed schedule was assigned a record number and did not bear the interviewee's name. Multiple photocopies were made for analysis, and the mastercopy was kept for reference.

Qualitative data were analysed inductively according to methods described by Reilly[185], and Bogdan and Biklen[182]. The word-processed transcripts of questions were read several times to identify patterns and 'instances' of common and/or important issues, which were highlighted and counted as appropriate. If a respondent clearly answered a question before it was asked, such concepts were analysed with any other response to that later question. (*Epi Info Version 6* was used for quantitative data analysis.)

Chapter 9: Results

Problem-based learning

Characteristics of tutors (Table 1)

Most of the tutors were male, two-thirds were medically qualified, and there was much accumulated experience of teaching medical students (424 years' worth!) from different backgrounds. Even for those considering themselves to have experience of problem-based learning (PBL), this was very limited.

Essential characteristics (Table 2)

Most tutors described PBL as student-centred (68%) small groupwork (53%), focusing on its philosophy including various aspects of knowledge acquisition (efficiency, contextualization, integration) and activation of prior knowledge. Evaluative components were relatively neglected. The following transcripts of this core question (◗ *denoting full response with minor editing*) are used 'in full' especially to illustrate breadth of responses. Four cover numerous concepts, the fifth is relatively superficial, and the last has a worrying 'traditional edge':

- *"...it's... students finding out things for themselves... and hopefully learning things in context so that they'll remember them in context, so learning useful things in a way that you'll recall them in a useful way later..."* **Anything else?** *"It's just an upside down way of learning things, looking at the problem to begin with and learning the things that are relevant to that rather than learning things in isolation and trying to put them together later... 'it's just a way of integrating knowledge really."*
- *"...the students are presented with an unseen problem, a new problem, and that they activate their prior knowledge in an attempt to solve that problem, that in doing so they will identify gaps in their knowledge, and that they will then go off to study to fill in those gaps, as a result of which they will come back and, hopefully, will actually generate more new gaps in their knowledge, that it's a sort of iterative process... but they will be closer to explaining the*

Table 1: Problem-based learning (PBL) tutors study group - characteristics

N=34

For the first cohort of (i.e. foundation) PBL tutors:		**n (%)**
◗ *sex*	*male* 26 **(76.5)**; *female* 8 **(23.5)**	
◗ *age (years)*	*30-34* *35-39* *40-44* *45-49* *50-54* *55-59* 2 8 9 5 6 4 ∴ 17 **(50.0)** aged 35-44 years	
◗ *medically qualified or not*	23 **(67.6)** *medically qualified* (from 1964-86) ; 11 **(32.4)** *not medically qualified:* • of 25 university employees: 2 basic scientists (medical); 9 basic scientists (non-medical); 7 clinical doctors (mostly hospital); 2 public health doctors; 4 medical educationalists (medical); 1 medical educationalist (non-medical); • of 9 non-university employees: 1 nurse; 4 hospital doctors; 4 general practitioners	
◗ *no. (out of 21)* → *of tutorials tutored*	*5* *9* *12* *15* *19* *20* *21* 1 2 1 1 3 7 19	
(For 31 groups)	∴ 19 **(55.9)** *tutored all 21* (range 5-21); [5 tutorials being taken by reserve or no tutor]	
◗ *considered themselves to have had previous experience of PBL*	*yes* 10 **(29.4)**; *no* 24 **(70.6)**	
◗ *undergraduate medical teaching experience*	range 0-30 years; median 12.5 years; cumulatively 424 years	

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Table 2: Problem-based learning (PBL) tutors' concepts of PBL - essential characteristics

N=34

"What, for you, are the essential characteristics of PBL?" **The essential characteristics *include* that it:**	mentioned by	n	(%)
◗	is student-centred	23	**(67.6)**
◗	involves small-groupwork	18	**(52.9)**
◗	is about active learning	14	**(41.2)**
◗	involves a PBL tutor	14	
◗	allows knowledge to be acquired in a more efficient way	10	**(29.4)**
◗	is based on sequential steps	9	**(26.5)**
◗	is a way of learning that which is relevant (in context)	9	
◗	is a way of integrating subject knowledge	7	**(20.6)**
◗	motivates students	5	**(14.7)**
◗	activates prior knowledge	5	
◗	involves problem-solving	5	
◗	allows life-long learning skills to be acquired	3	**(8.8)**
◗	has an evaluation phase	2	**(5.9)**

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problem when they come back." **Anything else?** *"...really has to be small group work; [large group PBL is] a difficult concept... [It] should be cooperative... teamwork."*

- *"Students being involved, being active, being excited... learning things that they seem to want to learn... using a little bit of what they already know to try to explain things... getting to know each other... teamwork... providing mutual support... being concerned and interested about each other as well as themselves... checking... themselves... against each other... making better use of resources than in the old course... asking questions of resources... [getting out and about around the campus]... They are getting a bit canny in terms of finding stuff like library books and Internet bits..."* **Anything else?** *"...we could go for ages about PBL... it was the essence of it that was the activity of the students... [Also though they are] evaluating themselves... what it was like for them and how they might improve, [which is still rudimentary and needs a lot of tutor support to get] out into the open [how they feel]... talking, presenting, growing for themselves... [presentation skills]... justifying [what they know]."*
- *"An active learning process for the students... very student-centred... relies on a very... good group process for the students... teamwork... very adult way of learning but in a way harks back to the way that children tend to learn - it's a fairly natural form of learning to explore issues using a problem... [The problem is] a device or vehicle for setting a learning agenda... they [the students] set the issues. [The depth depends partly on] liberating their prior knowledge [and partly on learning the skill of] how much detail to go into. [It] relates very much to the students themselves... [it] occurs within a framework of learning and a framework... of where they're supposed to get to... [with a more natural endpoint... and with the four themes]. It almost needs to be messy, but through that mess they learn a lot about the sort of activities that you need to do around critical appraisal - finding out information, sifting information, working together as a team in a safe environment, which is kept safe for them, if it needs to be policed (if you like), by the PBL tutor, whose role is more about the group process than about any of the content... It's had a good write-up... elsewhere it's been proven to have advantages over some of the more traditional ways of learning... [It is a fun way of learning]... keeps the students motivated... [- they don't get] turned off [but] turned on [more as they go along]... [and is] quite stimulating [even for the tutor... The tutor is] not participating [as such. It is participative for the students]... a good way of learning, [for] taking on context [and giving opportunities for practising lifelong learning skills... especially in medicine when things are moving on so quickly]... It is setting their learning in context [to get to some of the same content (e.g. Structure & Function) in] a more relevant way [even in some of the] drier scenarios [of Semester 1. It is integrating (without students even realizing it)... using prior knowledge]... learning by doing... a very human way to learn and people make mistakes including tutors."* **Anything else?** *"...very fallible process."*
- *"...it's not subject-based, it's problem-based... a straightforward answer."* **Anything else?** *"...student-centred or student-led..."*

- *"For me, PBL is a vehicle in the 1st year to teach students... basic concepts of basic science, obviously combined with a clinical problem and a corresponding, and erh other issues, so in my mind, we have a problem, which is a clinical setting and then I explore with the students... the basic physiology, biochemistry, anatomy, genetics, and so on, which fits in that module, and then we go to the clinical aspects very briefly, and then the corresponding public health, social issues..."* **Anything else?** *"...No..."*

Two responses partly characterized PBL in terms of what it was not, i.e. not about problem-solving (as reiterated when questioned later specifically about their relationship), e.g.:

- *"What it's not, is it's not, not, problem-solving; [it's about] setting learning in a context [so that students can] learn things [that they perceive they need to know]. "[There must be a clear] line drawn [between PBL and problem-solving]... the two don't really overlap."* **Anything else?** *"If it's going to work properly [students need to set their own] learning objectives."*

Changes and expectations (Table 3)

Fifty-six percent of tutors indicated a changed view of PBL with Semester 1 experience. The unfocused responses included rather disparate conceptual and evaluative comments, not all clearly change-related. The following (▸ *denoting 'extract' from response*) comprise neutral, positive, and negative conceptual comments, respectively:

- *"...[the Maastricht] method of PBL is very much directed towards a specific problem...* ***---edited---*** *...and the students go out to answer that problem whereas in our scenarios, there are often a dozen different aspects that the students could look up and I haven't made my mind up which is better...* ***---edited---*** *Our way they could easily go off and spend a lot of time on lots of different aspects because there isn't just one problem in our scenarios..."*
- *"...more successful...**---edited---** ...can genuinely integrate all those things rather than just paying lip service to them."*
- *"...a lot more difficult...[because i) when and how to intervene is problematic, and ii) the expertise required to intervene properly (e.g. imagine being in an English or French tutorial; e.g. George Eliot's novels in an English tutorial)]; you don't have the jargon, the understanding, or the knowledge framework to be able to intervene properly. [This is fine when the group is working, but not when it is not...* ***---edited---*** *...you may let something [incorrect] through...*

Table 3: Problem-based learning (PBL) tutors' concepts of PBL - changes and expectations

N=34

"How has your view of PBL changed (if at all) since you started as a PBL tutor?"					
My view has:				n	**(%)**
◗ not changed at all				13	**(38.2)**
◗ changed in some way:				19	**(55.9)**
Of these 19 tutors, 18 made ≥ 1 comment(s) on and/or:	positive from 7	neutral from 8	negative from 9	---	---
◗ concepts	10	9	7	---	---
◗ practical issues/local implementation	1	2	9	---	---
◗ *evasive answer*				2	**(5.9)**
				34	**(100)**

"Has the PBL tutoring experience matched your expectations?"		
	n	**(%)**
◗ Yes (Yes 4; Yes, but not high 2; Yes, but... 18; Yes, and even better 5)	29	**(85.3)**
◗ No	2	**(5.9)**
◗ *evasive answer*	3	**(8.8)**
Related comments:	34	**(100)**
◗ Positive	46	---
◗ students' progress (e.g. learning in general; learning in context; coping; taking to it; enthusing; working hard; building on prior knowledge; appreciating knowledge limits; impressive intellects; group's maturity)	20	**(43.5)**
◗ tutor's enjoyment (e.g. enjoyable; interesting; worthwhile)	11	**(23.9)**
◗ tutor's personal development (e.g. learning/revising about medicine; learning about education; invigoration; personal growth; confidence in own ability)	7	**(15.2))**
◗ other (e.g. less time/preparation; tutor/student relationship; value to students for the future; going smoother than expected)	8	**(17.4)**
from 20 tutors	46	**(100)**
◗ Negative	51	---
◗ time-consuming	8	**(15.7)**
◗ curricular implementation (late tutor guidance materials)	4	**(7.8)**
◗ curricular implementation (other)	8	**(15.7)**
◗ tutor development programme (e.g. tutor training and attendance, mentor system)	4	**(7.8)**
◗ other (e.g. own ability/expertise; amount of facilitation required; tiring; doubts about concept; group dynamics; student anxiety/frustration; tutor enjoyment; loss of control; curricular design; time for students to adapt; superficial learning; little feedback)	27	**(52.9)**
from 20 tutors	51	**(99.9)**

All percentages do not add up to 100% because of 'rounding'.

[which is] worrying... although you assume in pure PBL they will get it right, but... [mistakes are being made]."

Only one tutor gave an unwavering negative view of PBL (sustained in other responses):

- *"Absolutely not, no. ...views not really changed at all. I'm still not convinced that PBL, despite the fact that [I will tutor again]... is the proper way of teaching."*

Of two tutors whose experience fell substantially short of expectations, one was clearly unnerved by it and the other philosophical about having had a dysfunctional group:

- *"No it hasn't, not at all... [not enjoyed it at all... inexpertise]... you cannot be expert in every particular area. [Because of inexpertise it is very difficult i) if the] group won't get a discussion going; [and ii) if the] discussion gets going things can go over your head and can be wrong and you just have to let it go... can't query... if... it falls dead, you can't pick it up... can't take part... may be at a very very superficial level or too deep [e.g.' molecular biology]... It's quite easy to keep asking the question 'why?'"*
- *"...my group were the worst group I'd ever taught... but... it was OK [despite group dysfunction] we got through the problems and... there was no crisis; we... all worked through it could have been more fun [and in more depth, but was adequate]."*

Of those whose experience largely matched their expectations, one tutor had also been unnerved by the experience and yet was positive about PBL:

- *"**---edited---**...I am more convinced that students can learn something this way. I'm much less convinced that I'm an appropriate person to be a PBL tutor..."*

Most of the positive comments about expectations concerned students' progress (44%) and tutors' enjoyment and personal development (39%). Corresponding negative comments were more disparate, most concerning curricular implementation (24%) and PBL being time-consuming (16%). The tiring nature of PBL was noted by one tutor:

- *"**---edited---** You do about an hour-and-a-half in an afternoon but it's very difficult to get down to concentrating on anything else like writing a paper after that. You're just in a totally different mode."*

Even the tutor most negative about PBL had enjoyed it:

- *"...Yeah... I've quite enjoyed it, despite the fact that I'm... still doubtful of the whole concept of problem-based learning. I... wouldn't say I disagree with it. I'm just doubtful that the system works. I think what we're doing with tertiary education now is what we did with primary education 25 years ago and secondary education 10-15 years ago... that was absolute mess, [need to get] back to teaching children to read and write and do arithmetic properly."*

Comparisons with other tutors and Faculty (Table 4)

Forty-seven percent of tutors indicated isolation from sharing experience with tutor colleagues (irrespective of the training programme), as illustrated by the tutor unconvinced about PBL, the tutor unconvinced of his/her suitability for tutoring, and another expressing a minority viewpoint about training, respectively:

- *"...to begin with I was prejudiced against PBL... I didn't ever go to any initial tutor training..."*
- *"I haven't a clue; sorry, I haven't a clue... I just don't know... The only person I've talked to is supposedly my mentor... so that doesn't really count. Noone else around here seems to be doing it apart from me and..."*
- *"I... haven't really discussed PBL very much with [them]... initially went to some of the tutor training sessions, but... last couple [attended were] pretty much a waste of time..."*

Comparing themselves with others, tutors' passing references to other tutors' practices predominated, 60% of comments revealing concerns about some maintaining a traditional teaching role, e.g.:

- *"**---edited---** I don't know how many of them... had training in... groupwork before outwith this. **---edited---** I'm not altogether sure... [about the tutors' preparedness]. I suspect that less than 50% of the tutors had as [sic] clear an idea of what they were going into... [also based on students' feedback from other groups]... very much... hearsay [but] some tutors were very directive [and]... actually brought in lecture notes... gave them information."*
- *"**---edited---** Some have found it difficult to step back and not do a] straightforward question and answer tutorial slipping back into the old*

Table 4: Problem-based learning (PBL) tutors' concepts of PBL - comparisons with other tutors and Faculty

N=34

"How do you think that your view of PBL compares with...?"		
Other first semester PBL tutors:	n	**(%)**
◗ Do not know, did not speak to any/many	16	**(47.1)**
◗ There is a wide spectrum of views	12	**(35.3)**
◗ They are similar, but...	6	**(17.6)**
Related comments:	34	**(100)**
◗ About the tutoring practices of others, i.e. that some were:	20	---
▒ very didactic/directive; giving information; pursuing personal agendas; ignoring the philosophy	12	**(60.0)**
▒ unprepared for groupwork; not understanding PBL; following a recipe; uncomfortable with it	4	**(20.0)**
▒ other, e.g. nicely surprised; felt isolated; unable to stop being specialized; inappropriately inactive	4	**(20.0)**
from 20 tutors	20	**(100)**
Faculty of Medicine (e.g. via written materials about the curriculum; via the tutor training programme, etc.)**:**	n	**(%)**
◗ No difference	12	**(35.3)**
◗ Different	19	**(55.9)**
◗ Possibly different	3	**(8.8)**
Related comments:	34	**(100)**
◗ Differed in that Faculty:	25	---
▒ were wrong in telling us to be so inactive originally	7	**(28.0)**
▒ other	18	**(72.0)**
from 19 tutors	25	**(100)**

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*mechanism... substantially... most... will agree with [me] at least in part... **---edited---** Some] say the words... whether... whether they've actually got that in their bowels...?"*

Various differences were cited by the 56% 'disagreeing' with 'Faculty', the most common comment being about Faculty initially overemphasizing non-intervention:

- *"...probably a bit more directive than the **original** message but I think that the message is shifting as a result of our experience... I think we're all sort of shifting... what Faculty is saying is shifting slightly to [being more directive] as well... [at first], it was quite sort of loose and a lot of people thought it was a question of sitting there and not saying anything... [now] a clearer message coming through that that's not what it is."*

Comparisons with students (Table 5)

Comparisons with the students' views of PBL were overshadowed by related comments that mostly (44%) referred to students' developmental adaptation with time (up to the whole semester):

- *"They became very 'twitchy' when they were a bit unsure of how much to learn in a formal sense... I think they were getting used to it after the first 5 or 6 weeks and... all bar one were enjoying it... One... I think... may well **still** be twitched about it... ha ha."*

Reasons for volunteering for the role (Table 6)

General curiosity about something 'new', educational interest, and personal development opportunities were most commonly cited for becoming PBL tutors, (19%, 9%, and 9% of the diverse reasons given, respectively).

Characteristics of a good PBL tutor (Table 7)

Knowing when and how to intervene, empathy with the students, and enthusiasm were the most commonly cited characteristics of a good PBL tutor (14%, 10%, and 8% of

Table 5: Problem-based learning (PBL) tutors' concepts of PBL - comparisons with students

N=34

"How do you think that your view of PBL compares with...?"		
Your Semester 1 group of students:	n	**(%)**
Related comments:		
◗ The students started off uncomfortable and became less so	7	**(20.6)**
◗ The students started off uncomfortable and became less so, and were positive about it (see below)	3	**(8.8)**
◗ The students started off uncomfortable and became less so, but particular students were very uncomfortable with it	5	**(14.7)**
◗ The group of students were uncomfortable with it	5	**(14.7)**
◗ The group of students were uncomfortable with it, but particular students were very uncomfortable with it	1	**(2.9)**
◗ The students were positive about it (e.g. positive; happy; enjoyed it, favourable/ enthusiastic about it; comfortable with it)	8	**(23.5)**
◗ Our views were similar (no further comments)	3	**(8.8)**
◗ *evasive answer*	2	**(5.9)**
	34	**(99.9)**

All percentages do not add up to 100% because of 'rounding'.

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Table 6: Problem-based learning (PBL) tutors' concepts of PBL - reasons for volunteering for the role

N=92 (≥1 reason(s) each from 34 tutors)

"Why did you 'volunteer' to be a PBL tutor?" **...because:**	n	**(%)**
◗ of curiosity; it is an interesting thing to do	17	**(18.5)**
◗ of interest in education; it is an interesting educational approach	8	**(8.7)**
◗ of personal development opportunities	8	
◗ traditional undergraduate medical curriculum had lots of problems	7	**(7.6)**
◗ education is a responsibility of my role	6	**(6.5)**
◗ the department/practice wanted to make a contribution	6	
◗ of my role in curricular development	5	**(5.4)**
◗ I would have *been* volunteered if I had not volunteered myself	4	**(4.3)**
◗ enthusiasm for, belief in the new curriculum	4	
◗ it looked like it should be fun, enjoyable	4	
◗ of teaching obligations to undergraduate medical education	3	**(3.3)**
◗ affinity with, skills in small-groupwork	3	
◗ of loyalty to links with the Faculty, personal support for key figure	3	
◗ it is a 'nicer', more effective way of teaching	3	
◗ it seemed like a good idea at the time	2	**(2.2)**
◗ of relevant involvement in postgraduate medical education	2	
◗ of better student contact	2	
◗ was stimulated, 'trapped' by the training abroad	2	
◗ of wanting to 'do my bit'	1	**(1.1)**
◗ of the opportunity to promote a multidisciplinary stance	1	
◗ I was told to	1	
	92	**(100.1)**

All percentages do not add up to 100% because of 'rounding'.

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Table 7: Problem-based learning (PBL) tutors' concepts of PBL - characteristics of a good PBL tutor

N=102 (3 characteristics each from 34 tutors)

"What makes a good PBL tutor? It might help to focus on your 'main 3 elements'." **A good PBL tutor:**	n	(%)
knows when and how to intervene	14	**(13.7)**
empathizes with the students	10	**(9.8)**
is enthusiastic	8	**(7.8)**
understands, is committed to PBL	7	**(6.9)**
facilitates a safe environment	6	**(5.9)**
has the students' learning as the top priority	5	**(4.9)**
is medical	5	
is a good listener	5	
is confident to let the process work	5	
has enough knowledge of the topic...	4	**(3.9)**
is good at group dynamics	4	
has a broad view of health issues (e.g. public health, general practice...)	4	
brings the students out	3	**(2.9)**
is flexible	3	
is committed to educational innovation	2	**(2.0)**
is a good communicator	2	
is interested in the students	2	
is reliable (punctual, organized)	2	
works hard by concentrating during the session	2	
is patient	2	
is approachable	2	
has a good background in medical sciences	2	
makes time for PBL	1	**(1.0)**
should not be expert in the field in which they are tutoring	1	
has a sense of fun and perspective	1	
	102	**(100.2)**

All percentages do not add up to 100% because of 'rounding'.

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suggestions, respectively). The knowledge perspective was not ignored but not the top priority.

Main advantage and disadvantage (Table 8)

The most commonly cited main advantages were maintaining students' interest and enthusiasm (24%) and equipping them with lifelong learning skills (21%). The most commonly cited main disadvantages were generating fear of knowledge gaps (32%) and the resource-intensive nature of PBL (24%).

Problem-solving

Problem-solving and its relationship to PBL (Table 9)

Most tutors had apparently never actively considered problem-solving skills before, yet all except one attempted to talk through, however briefly, likely elements and/or comment on the concept. The most common elements identified were problem analysis by 74%, and data collection by 32%, while 29% indicated an organized process, as illustrated by the following (also unusual in mentioning synthesis, and evaluating achievement of objectives, respectively):

- *"It is the ability to approach a problem or situation to distil the essence of the problem from the... irrelevance around it, decide what information is needed to solve that problem, go and get that information, if it's not immediately at hand, and then see how... formulate a... hypothesis or course of action and see how that... bears up with... experience and the information that's been obtained."*
- *"...looking at a problem and analysing it, [seeing] what the problem actually is; [firstly] do you have the information that will help you solve that problem? [Secondly], what information is it that you require and where are you going to seek out that information from? [Then] knowing that you've actually solved the problem at the end of the process."*

Table 8: Problem-based learning (PBL) tutors' concepts of PBL - its main advantage and disadvantage

N=34

"For PBL, then, what do you see as its main advantage... main disadvantage?" **The advantage is that it:**	n	(%)
maintains students' interest and enthusiasm	8	**(23.5)**
means that students acquire lifelong learning skills	7	**(20.6)**
is active learning	6	**(17.6)**
is student-centred	5	**(14.7)**
is a healthy/natural way to learn	2	**(5.9)**
integrates knowledge	2	
has a tremendous social advantage	1	**(2.9)**
results in a close staff-student relationship	1	
ensures that students internalize their learning better	1	
encourages students to share knowledge	1	
	34	**(99.8)**
The disadvantage is that it:	n	%
generates fear that the students will have gaps in their knowledge	11	**(32.4)**
is resource-intensive (time, tutors, texts, technology)	8	**(23.5)**
is unsuited to students straight from school	3	**(8.8)**
is difficult to get the knowledge level right	2	**(5.9)**
results in a diversity of experience	2	
is countercultural (logistical problems for institution)	2	
requires so much staff training	1	**(2.9)**
requires effort/expertise for the case scenarios to reflect the learning objectives (and not be facile/misleading/overcomplex)	1	
will attract some tutors because it is a good thing to do, but they will not do it well	1	
loneliness for the tutor (because not actively teaching)	1	
is potentially anxiety-provoking for students	1	
...nothing that cannot also apply to traditional curricula	1	
	34	**(99.8)**

All percentages do not add up to 100% because of 'rounding'.

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Table 9: Problem-based learning (PBL) tutors' concepts of problem-solving - and its relationship to PBL

N=34

"What do you understand by the term problem-solving skills?" **Problem-solving skills involve:**	n	(%)
◗ analysing the problem (e.g. define; analyse; distil the essence from the irrelevance of; get to grips with; dissect; examine in detail; break down; perceive; weigh up; understand; hypothesize about; intellectualizing **the problem/question/scenario/situation**)	25	**(73.5)**
◗ exploring alternative solutions (e.g. look for possible solutions; formulate your solutions)	2	**(5.9)**
◗ using your existing knowledge (e.g. your core of knowledge; applying your knowledge)	2	**(5.9)**
◗ using data provided (information, data given)	2	**(5.9)**
◗ collecting data (e.g. decide what information is needed and go and get it; collect data; research; read about it; seek out aids; acquire necessary knowledge; identify information resources)	11	**(32.4)**
◗ synthesizing (e.g. synthesize it all together; see how it bears up with information obtained; putting lots of heterogenous material together)	4	**(11.8)**
◗ finding one final answer (find or get to, e.g.: the answer; an answer; a clear end-point; a solution; a 'black-and-white' solution; a best answer)	11	**(32.4)**
◗ not finding one final answer (several solutions; not always an... not necessarily *the*... definitive answer)	6	**(17.6)**
◗ considering whether you have achieved your objective (e.g. feeding back to analyse achievement; knowing that you have solved it)	2	**(5.9)**
◗ being organized (e.g. being organized; structured; methodical; using steps)	10	**(29.4)**
"How does 'problem-solving' per se fit into your view of PBL?" **Concerning problem-solving skills and problem-based learning:**	n	(%)
◗ problem-solving skills have an important role in problem-based learning	18*	**(52.9)**
◗ problem-solving skills have a minor role problem-based learning	3*	**(8.8)**
◗ problem-based learning is much more about knowledge acquisition than problem-solving skills	9*	**(26.5)**
◗ *evasive answer*	3	**(8.8)**
◗ *"Phhhh... I don't know."*	1	**(2.9)**
	34	**(99.9)**

*In each group, 2 indicated that problem-solving skills could be used to pursue the students' learning objectives.

All percentages do not add up to 100% because of 'rounding'.

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Only one tutor referred to thinking (i.e. *"thinking creatively"*). Only half referred to the 'result(s)', most suggesting a single outcome as in this tutor's 'first-time thoughts':

- *"Gosh, these are very difficult questions! ...skills? [I'm thinking] nothing at the moment! ...a clear definition of the problem... what you're trying to solve, a methodical outlook, to go through it in a coordinated way so that you're getting to the problem, erh, not haphazardly, erhm, and a clear endpoint - you know... actually coming out with an answer."*

Only seven (21%) tutors made any specific, evaluative or theoretical comments, i.e. that problem-solving skills are:

- task-specific *"from my reading"* and non-existent as generic skills;
- *"almost the most important thing"*;
- about the *"novice versus expert approach to things... it lies there somewhere"*;
- a *"very natural thing to do... a lot of human behavior is... based on that"*;
- are missed by many conventional students;
- *"not something that they do in problem-based learning"*;
- of two types, used in calculations and investigating clinical scenarios, respectively.

The last came from a rather confused response focused more on day-to-day PBL tutorial issues.

Nine tutors (26%) illustrated their responses with situations in which problem-solving skills are used, mostly clinically-based, e.g.:

- *"It conjures up... 42 surgeries a week... about 300 consultations, ha ha"*;

- not A-levels and multiple-choice questions; *"very important clinically"*, adapting management to patients;

but two were broader in outlook:

- *"covers anything from... 'what am I going to eat tonight?' to solving the problems of the Liverpool economy"*;
- *"It's like seeing a box of matches fall out on the floor; you have to line them up in a way that they can be put back in the boxes... the way you want them with all the heads up at one end..."*;

Responses to *"Do you think that problem-solving skills: can be taught..."* and *"...are transferable?"* were generally superficial. They were considered teachable (in an apparently uncomplicated way) by 17/34 (50%). The term 'taught' was questioned by 9/34 (26%) (favouring 'improved', 'practised', 'acquired', 'developed'), one alluding to bringing such skills into consciousness:

- *"No... wait a minute, taught? Ha! They can be acquired in a teaching situation... not in a lecture... If as a facilitator you reflect back to them [if working in a group]... 'What have you just been doing?' 'Why did that work?'... then [it helps them to recognize it to use it again. It is like a good tennis stroke... when it goes right you say 'Why did that go right?' [and then they identify it]."*

Four referred to learning by 'doing' or 'experience'. Of 4 with reservations, 2 mentioned content-specificity. Concerning transferability, 19/34 (56%) gave unqualified agreement. Only 6/34 (18%) mentioned content-specificity and/or little evidence of transfer.

Over half the tutors considered problem-solving as core to PBL, but gave generally very superficial, unconsidered responses, e.g.:

- *"I think it fits it very nicely, because when you have your scenario... [or it should do]."*
- *"Yes. The students were presented with problems... and the two to me seem intrinsically bound."*

The 27% of tutors conceptualizing PBL as more about knowledge acquisition than problem-solving skills gave more considered responses, e.g.:

- *"...[they're going in] slightly different directions... [in PBL] trying to generate lots of options and a learning agenda... [in problem-solving similar early on but then 'hone down'. PBL is going wide, coming in a little bit but] staying broad; [problem as a basis, not necessarily as something to solve; can use problem-solving skills to answer learning objectives; PBL is a learning vehicle.] I don't think that PBL is about problem-solving... although some of the skills that they're picking up... are going to help them... with differential diagnosis. [The end-points are different.]"*
- *"It doesn't. I don't think PBL is about teaching problem-solving. [I have a major difference with Barrows' approach of using the approach to teach problem-solving skills.] I use PBL to teach the basic knowledge that people need... as a curiosity generator; not to teach problem-solving skills."*

The first above (and an evasive response) suggested that problem-solving can be acquired 'in passing'. The last was of a pair denying that PBL was about teaching problem-solving skills.

The curricular themes

Undergraduate medical curricular themes (Table 10)

Approximately three-quarters of the tutors showed at least 'basic' understanding of the nature of the *Population Perspective* theme:

- *"**---edited---** I can even deal with Population Perspective, you'll be pleased to hear... [It is about] looking at things on a large scale, of trying to plan, of looking at trends... I can see that there are principles, means of dealing with data... outcomes... that you can work with... **---edited---**"*

(but 7/25 (28%) admitted conceptual difficulty). The remaining quarter evaded outlining it, except for two confusing it with *Individuals, Groups & Society*, and one confusing it with itself!:

Table 10: Problem-based learning (PBL) tutors' concepts of the Liverpool undergraduate medical curricular theme - *Population Perspective*

N=34

"In your view, what are *the* essential differences between the four curricular themes, *Structure & Function (S&F), Individuals, Groups & Society (IG&S),* ***Population Perspective (PP)****, Professional Values & Personal Growth (PV&PG)*?" **Concerning their description of the *Population Perspective* theme:**	n	(%)
◗ gave an explanation consistent with its nature e.g. (edited extracts*) ⋗ *"...public health... [altering] incidence... countrywide strategy..."*; ⋗ *"...knowledge of epidemiology... commonness, importance... data handling and interpretation... [and relevant attitudes]..."*.	25	**(73.5)**
◗ admitted that it was difficult to conceptualize and/or 'bring out'†, (alone or together with IGS & PVPG), e.g. (edited extract*) ⋗ *"...I think they covered [Population Perspective] in a number of different ways... There's bit of a kind of overlap there... I'm not clear... if... - how common cancer is in the United Kingdom, well you could say it was Population Perspective, but also it's to do with Society isn't it? [There's a] lack of clarity in my head..."*.	9	**(26.5)**
◗ revealed indifference or antagonism to it†	8	**(23.5)**
◗ conceptualized it as one of *"[the other three themes]"*	16	**(47.1)**
"Given these differences between the themes... ...what implications (if any) do you consider them to have for the use of PBL?"	n	(%)
◗ themes need clarifying/adjusting/matching to learning resources e.g. (edited extract) ⋗ *"...The definition needs to be made a lot clearer and examples need to be given both to students and to the tutors."*	18	**(52.9)**
◗ case scenarios need rewriting to 'bring out' the other three themes e.g. (edited extract) ⋗ *"...[The Population Perspective objectives on the Faculty agenda do not come out of the cases; often] we can't get to that from the case."*	10	**(29.4)**
...and given differences in the disciplinary backgrounds of tutors, what implications (if any) do you envisage for the balance of 'interventions' (by the tutor in group process) across all four themes?"	n	(%)
◗ balance of interventions will vary with tutors' backgrounds (especially *Structure & Function* versus other themes), e.g. (full response) ◗ *"...[with inexperienced tutors (i.e. all of us)... will show] favouritism in the themes... [more comfortable and will intervene in 'own theme'... (message given re more importance)... less likely under other themes] to spot when going 'off-beam'... might overcompensate by clutching on to the driftwood of the Faculty handbook 'stuff' and the study guides... [potentially favouritism... saying nothing about areas you know about and too much about areas don't know about]."*	32	**(94.1)**
◗ ideal tutors should guide on *all* themes/leave 'disciplines' out of it, but only 1 maintained that this could/should always be so, i.e. (full response) ◗ *"...only if they are a lousy tutor... a good tutor would ensure that each of those was addressed and [he/she] should attempt to provide some sort of a balance."* (Other 3 conceded that this probably could not reflect reality.)	4	**(11.8)**

*Not from the two public health doctor tutors. †The tutors giving these responses (n=9, n=8, respectively) do not overlap.

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- *"**---edited---** I felt very much that Population Perspectives [sic] has been public health and very little else; hard to say that to you isn't it? **---edited---**"* **[[evidently not!]]**

Of the mild indifference/antagonism revealed by 24%, the most 'extreme' was:

- *"**---edited---** [The other three themes don't appeal enormously to me... I could not distinguish Individuals, Groups & Society from Population Perspective... and find it very difficult to] tease out... [the other three themes] - I can't recite it even, the Population Perspective and all that sort of thing... quite deep thoughts [that don't] appeal to me or probably relatively junior university students... [They are] all very abstract ideas and maybe I'm just not an abstract person... My heart wasn't in it... [nor were the students']; whether they reflected my bafflement by the whole thing or not, I don't know... I know that 'the Great and the Good' say that we must be 'all singing and all dancing' in all these areas, but [that's very hard]... **---edited---**"*

Only 14/34 (41%) of tutors (including two public health doctors!) outlined the theme adequately without (like the remainder) being confused with (3), revealing discomfort with (9) or antagonism/indifference to (8) its conceptualization.

Population Perspective was classified with 'the other three themes' as very different from *Structure & Function*, with which most tutors were most comfortable. Some entire attempts to delineate all four themes were short, but still made this point:

- *"[Structure & Function]... is [about]... the building blocks and the most tangible... part of the course that you can get a handle on... "[The other three themes] are all... subjective [and I cannot distinguish between them or describe them]."*

In outlining *Structure & Function* initially, 24/34 (71%) indicated the comparative ease with which they personally conceptualized it (easy/straightforward; self-evident).

Strengthening/adjusting the thematic structure was mentioned implicitly/explicitly by approximately half. Most (94%) tutors envisaged interventions varying particularly with tutor background (referring to thematic more than subject differences). A 'fact' versus 'non-fact' division emerged concerning implications of the themes:

- *"I don't know what you turn them into, but I would be happy to discuss... other options or what they meant. Sometimes I think the themes were too philosophically vague. I mean, Structure & Function you know exactly what that means. Personal Development, everybody knows what that means (you can see it in your mind's eye). I couldn't see the others really. I didn't quite know where they began and ended... I like concepts..."*

...Oh, and by the way (Table 11)

"Oh, that's pretty profound isn't it?..." began one tutor when asked for further comments about PBL as a guiding *philosophy*. The responses were a 'mixed bag' of comment, contemplation, commitment, concern, congratulation, confusion, and caution. [Notably, one tutor argued vehemently with the researcher's pre-Question 1 introductory paragraph(!), dismissing reference to *"...PBL process (both as method and **philosophy**)..."* as 'jargon'... then continued as an enthusiastic, helpful respondent!]

Table 11: Problem-based learning (PBL) tutors' concepts of PBL -
as a guiding philosophy for the Liverpool undergraduate medical curriculum *"...Oh, and by the way...!"*

"Have you anything further to say about PBL as a *guiding philosophy* for the curriculum?"

- *"...time is a problem, particularly [when developing in parallel with traditional course]; that's given me one or two headaches... For a tutor [if it's working well] it's not a particularly satisfying educational experience. [If it's not working well]... If I'm honest, it's not as satisfying as giving a good lecture. I'm quite pleased and happy [with their progress; that's rewarding]... Now they've got something to go on in the way of knowledge."*
  - *"I wonder if it's actually ultimately appropriate at the very beginning, whether... [need] a basic introduction [first]... That doesn't fit with their philosophy, but... [sometimes they needed] a founding knowledge [so that they could bring out] the other three themes."*
- *"For me... it's going to qualify whether it is a better process than the historical one. There's still some concerns about the fact that we've had a process for a hundred years from Liverpool and still in the country and are we saying that process was flawed... there's always room for improvement [though]... Is it going to produce a completely different type of doctor? ...It's going to take a long time to see whether we've made it right or wrong, and whilst most of us expect and hope it's right, if it is wrong... how do you approach that? ...We keep only bringing out the five or six areas in the world that have shown success, but we've not evaluated it against the many more hundreds of medical schools that... may say they're successful along traditional [lines anyway]."*
  - *"[It's] the only way to run a modern curriculum... The thing is we're all enjoying it."*
- *"I don't accept that it's just the 'be-all-and-end-all' of every bit of teaching that you've ever done. PBL is a method that doesn't stand alone; it's an integrated method; [there are lots of others we need to use]... The danger is that it becomes a PBL-only course. ...[It should be] 'horses for courses'. [You do not always need PBL to make small-group activity work. The danger is that everybody is going to go so 'PBL-mad' that we're going to forget all other group dynamics."*
  - *"I enjoyed it... The teething of a new curriculum... it was difficult to believe it had been planned for five years... ha, ha, ha!"*
- *"I don't think we taught our tutors very well... I don't think that many people had very good practice before the start... [Those] who went abroad probably had more than anyone else, but... [We first semester tutors... we've probably been] 'the cream' [haven't we (!?) as well]. More of the first semester group have been abroad than any of the other tutors. I don't think the lunchtime sessions have been particularly helpful."*
  - *"No, not really... I'm sorry I couldn't be more positive."*
- *"I think that it's been launched with a great deal of enthusiasm... reflected by... [people like me volunteering to be tutors]... and we're interested in feedback; [prepared to give it another go]. It is an 'act of faith'... [won't see results for 15-20 years... It's worth persisting with]... eventually will have to be running itself... [maybe with some of the] more senior students... [doing] some of the 'donkeywork'."*
  - *"I was fortunate in I had a good group who enjoyed it, that got on well together. ...everyone's more aware of the pitfalls as well as the pluses... definitely think it's a good thing."*
- *"...nothing... really [that I haven't already said]. You're speaking to a 'religious convert' in a sense... having done it, I think it's great and I'm really quite sad that I [can't have even more groups than I can manage currently given my other commitments]. I've found it thoroughly rewarding and... looking forward to... having another go."*
  - *"If we're going down the road of reducing content, you know, and we're happy with losing content [as told by the General Medical Council], then this is as good a way as any to teach."*
- *"My main thing is... tutor training, group facilitation, and communication skills is a very important part of it... identifying effective behaviour and encouraging it, [i.e.] implicit in good communication skills... [I keep saying it.] They all ignore me. Nonetheless, I will keep banging on saying it... it's very important."*
  - *"It's very enjoyable... once people have got the hang of it then they will begin to enjoy it a little bit more. I think it's thought to be a bit of a 'doss' at the moment, you know, but it's really hard work... I think tutors should really prepare themselves for it."*
- *"I think it's gone fairly well for the first semester. I wouldn't say it's gone startlingly well. There have been problems, particularly around resourcing issues... both for the students and for the tutors. I wonder how Faculty is going to deal with [the momentum it's gathering; the delivery; if resources actually do exist to do it] in later years."*

Year 1, Semester 1, Liverpool undergraduate medical curriculum 1996/97 (15 full responses selected from N=34)

Chapter 10: Discussion

By relating problem-based learning (PBL) to dramatic changes in undergraduate medical needs, **Chapters 2-7** set the context within which PBL tutors conceptualize this approach. Several main messages emerged. *Firstly*, contemporary expectations of professional competence challenge 'taken-for-granted' assumptions about science and knowledge. *Secondly*, stronger public health education is needed. *Thirdly*, PBL has spent most of its career inducing revolutionary (more than evolutionary) undergraduate medical reform and countering epistemological resistance. *Fourthly*, 'true' PBL is:-

- method *and* philosophy, curriculum-wide, supported by all curricular elements;
- aimed at efficient acquisition and structuring of knowledge arising *out of* working through (in an active, iterative, and self-directed way) a progressive framework of problems providing context, relevance, and motivation;
- built on prior knowledge, integration, critical thinking, reflection, enjoyment;
- achieved via facilitated small-groupwork and independent study; and possibly
- related to problem-solving only insofar as knowledge becomes more accessible.

Nevertheless, 'PBL conceptual fog' lingers over the literature. Moreover, reorientating the epistemological basis of a traditional medical school is ambitious. Foundation PBL tutors in Liverpool's new problem-based undergraduate medical curriculum (probably needing 'subject-knowledge' *and* facilitation skills) were therefore a potentially diverse source of concepts about PBL and related issues. This chapter focuses on:

- reviewing the research question, aim, and methods of the study of PBL tutors;
- interpreting its results given the nature of PBL;
- commenting on educational implications of this work.

Review of research question, aim, and methods

This study provided *one* way of describing the spectrum of PBL concepts held by foundation PBL tutors. Implicit in the research question was concern that, if these tutors conceptualized PBL and related issues in a *very* diverse and/or erroneous way, they could be inappropriate early role models. Conceptualization was the focus, i.e. tutors' knowledge and understanding, values and preferences, attitudes and beliefs. The research question did not explicitly embrace curricular evaluation but, without other opportunities, many respondents understandably took this perspective.

The method used combined 'qualitative' and 'quantitative' approaches, pragmatically allowing concepts to be accessed while accommodating context and constraints. Pursuing a 'pure' qualitative approach or entertaining a divisive quantitative/qualitative philosophy appeared unhelpful. *This* study had the researcher as key instrument, was descriptive and concerned with meaning, but was in a setting of debatable naturalness and used quantitative summaries to supplement inductive analysis[182]. Some generalizability was sought at least to provide insight for future tutor development, and the 100% response rate gave credibility.

Questionnaire survey-based 'quantitative' approaches have characterized some of the more evaluative studies of tutors' reactions on changing to PBL[186], and would have been less effort-intensive (especially without interviewing and transcribing). The response rate or the depth of response achieved would, however, probably not have been matched (especially without opportunities for researcher and respondents to

clarify misunderstandings). The ability of a questionnaire to reach large numbers offered no advantage here, because the *whole* sampling frame comprised these 34 tutors. While over-ambitious, it was just feasible to interview them all. Furthermore, even if the foundation tutors were atypical, there *was* no other cohort. Varying degrees of familiarity with the researcher (semi- or complete strangers, passing acquaintances, close colleagues, etc.) potentially influenced readiness to disclose information. Shorter interviews did not necessarily signal non-cooperation or lack of interest, but time constraints. Deciding against interviewing fewer tutors, face-to-face, in even greater depth was apparently not disadvantageous.

The telephone route gave no non-verbal cues, but concentrated the mind on content and delivery of response. It was no less natural than if respondents had 'hosted' the researcher's visit to their 'territory' (potentially more time-consuming and affected more by last-minute rescheduling by respondents). The permitted tape-recording was also unobtrusive by telephone. The flexibility of arrangements, signed informed consent (adding a layer of complexity but also credibility), and the researcher's tutor status possibly contributed to the response rate.

Nevertheless, the extent to which (according to Cornwell's health-related work) these 'public accounts' resembled respondents' 'private accounts' is debatable[187]. Tutors possibly rushed more through silences on the telephone, but it was assumed that their initial reactions to questions revealed issues most prominent in their minds. Tutors also possibly ignored issues thought to be 'well-known' (or too revealing) to the 'fellow tutor'/public health doctor/consultant' as researcher. This was balanced,

however, by many respondents giving conspiratorial 'asides' in the spirit of tutor colleagueship. Most respondents approached the questions about the curricular themes without explicitly invoking the public health background of the researcher.

The semi-structured interview comprised open-ended questions, in unstructured response format[66], as did the studies by Abdulrazzaq and Qayed[108]; and by Wilkerson and Maxwell, whose four-question format showed some similarities (**Box 10**)[180]. Comparable data were therefore collected from respondents explaining concepts in their own words, with minor loss of respondents' ability to impose their own structure on topics.

Box 10: Open-ended questions from Wilkerson and Maxwell's 'qualitative' interview study of foundation problem-based learning (PBL) tutors in Harvard undergraduate medical curriculum

- *"Why did you volunteer to teach in the New Pathway?"*
- *"What do you understand about the nature of the program at this point in time?"*
- *"What teaching skills will be important for you as a tutor?"*
- *"What do you believe about how students learn and what your role, in general, as a teacher should be?"*

Source: **Wilkerson & Maxwell, 1988**[180]**(p894)**

Without non-verbal cues, maintaining momentum of responses by conveying interest 'neutrally' was difficult. More extensive piloting was unlikely to have changed the interview schedule more than happened after the first two interviews. The personal details questions, rather than being intrusive or 'out-of-place', obtained information unavailable comprehensively from other sources, and 'officially' separated the interview from informal closing discussion. The retrospective element with

respondents recalling experience over different periods was unavoidable, but 'contamination' by Semester 2 experience was minimized.

The explicit contract of confidentiality meant erasing audiotapes after transcription, and presenting the results mindful of this. Consequently 'whole interview transcripts' have not been used to illustrate coding or coherent stories across questions for individuals because of the potential ease with which some of the comments could be linked and identified.

Analysis by induction was as rigorous as constraints permitted (and comparable with that advised[66,182] and reported by others[108,180]), but was weakened by lack of triangulation of evidence or a 'second coder' to verify content categories. It is, however, difficult to identify an alternative method for the former other than by anecdote and personal experience (with which the results are broadly consistent), or a way of performing the latter meaningfully without breaking confidentiality. Any 'checker' would not have been immersed in the data. Personally collecting, writing, and transcribing each respondents' answers deeply immersed the researcher in the data even before reading them on many occasions and checking through the analysis several times!

It is with such caveats and potential biases (systematic errors) in mind that the results are interpreted.

Review of results

This first cohort of tutors had much shared experience of traditional undergraduate medical education as student and/or teacher, but from a diverse spectrum of backgrounds. They were generally younger than the all-male foundation tutors studied by Abdulrazzaq and Qayed in the new United Arab Emirates medical school. Of these, 17/18 were recruited from other countries, only 7/18 knowing about PBL and only 9/18 convinced of its advantages[108]. An age comparison cannot be drawn with Wilkerson and Maxwell's study of 27 Harvard foundation tutors in the New Pathway track (alongside a traditional curriculum). These data were not provided beyond one-third being 'senior' faculty[180]. Wilkerson and Maxwell also excluded tutors with central roles in curricular innovation, mostly senior faculty (not a justifiable exclusion in *this* study).

Irrespective of the wide spectrum of personal characteristics of the tutors in *this* study, extensive contact will have collectively shaped the early experiences of over 200 medical students. The sparing but heartfelt references to various dysfunctions personally, or in groups, individual students, other tutors, or administration gave a 'telling-it-like-it-is' authenticity to many of the accounts. The discomfort of relearning[162,166] teaching was evident, but so were enthusiasm, commitment, and considerable appreciation of the experience (consistent with reports from elsewhere)[71,133,178,179].

It is encouraging that tutors' conceptualizations of PBL revolved around student-centred small-groupwork that refocuses the approach to knowledge away from

traditional perspectives. A continuing concern was summarized by the tutor who queried whether *"[some]... say the words... whether... whether they've actually got that in their bowels...?"*, but a shared understanding of PBL is a creditable first step. The evidence suggests that the main philosophy of PBL was conceptualized appropriately, but moderate confusion prevailed beyond that!

The lack of emphasis on evaluation of group process and progress was noteworthy. Such a perspective on evaluation continued into the conceptualization of problem-solving skills by it rarely being mentioned concerning achievement of objectives. Few characterized PBL in terms of problem-solving and yet, later, over half agreed, in a superficial way, that they were intimately related!

Over half the tutors admitted that their perspective on PBL changed with the experience. This point is often made anecdotally in the literature and is supported by Bernstein *et al*'s empirical findings, in the Toronto undergraduate medical curriculum, that tutors *and* students were more positive about PBL after personal experience[186]. Unsurprisingly, several tutors harboured considerable doubts about certain aspects. Generally though, tutors were positive concerning their expectations, mostly about the students' progress and their own enjoyment (compared with traditional approaches), and personal development.

Some sporadic comments resonated with personal experience, especially those from two tutors finding it enjoyable yet tiring. This illustrated that actively concentrating on the thought processes, interaction, and content from flitting and enquiring minds in group discussion is challenging. This contrasted with the tutor with mixed feelings

who admitted some nostalgic pangs for giving lectures rather than experiencing occasional boredom with students' discussion.

The comparative data concerning other tutors, faculty, and students understandably encouraged evaluative rather than conceptual comments, but provided context for the tutors' conceptualization generally. Mixed messages from faculty about the dynamics of tutor intervention caused considerable confusion, but this was understandable given the idiosyncrasies in the relevant literature. There was evidence that students tended to become more comfortable with PBL towards the end of Semester 1, with anxieties generally related to breadth and depth of learning. Understandably in these early stages, the generation of fear of knowledge gaps among students *and/or* tutors was the most commonly cited disadvantage. This betrayed some clinging to the traditional wreckage.

Of the many reasons for volunteering to be a PBL tutor, the emphasis on doing something new, educational interest, and personal development opportunities was not dissimilar to Wilkerson and Maxwell's volunteers, i.e. interest in education, reform, and colleagueship[180].

The commonest characteristics advanced for a good PBL tutor (when and how to intervene, empathy with students, and enthusiasm) were consistent with Schmidt's model of the effective tutor (i.e. subject knowledge and social congruence)[174]. When Abdulrazzaq and Qayed asked, *"What teaching skills will be important for you as a tutor in the system?"*, the commonest were communication skills, patience, and being

good listeners[108]. (Wilkerson and Maxwell asked a similar question but then did not present the result[180]!)

While some tutors revealed misconceptions and doubts about their role, this was possibly exacerbated by insufficient opportunities to share experiences, apparently from time constraints and/or their equivocal commitment to the tutor development programme. Applying student-centred learning to *themselves* as 'students' learning about PBL was not universally appreciated by the tutors.

The confusion surrounding the relationship between PBL and problem-solving was understandable. Most tutors had apparently not considered it before and did not recognize the complexity of the issue, and many who had read relevant literature were understandably unsure. It is unsurprising that tutors mostly from an academic background should concentrate on the analytical aspects of this elusive process. Nevertheless, the lack of consideration of creative thinking and evaluating achievement of objectives was noteworthy. Much of the debate about transferable skills, however, had apparently passed these tutors by!

Predictably, tutors from a 'traditional background' were more comfortable with *Structure & Function* than with the 'other three themes'. Many lacked a conceptual framework and/or commitment to guide *Population Perspective*, and had potentially conveyed unhelpful messages, explicitly or implicitly, to students. Discomfort and perplexity with *Population Perspective*, however, probably combined inadequate central guidance about the thematic structure with traditional prejudices, but were not irremediable. An overview rather than deep subject knowledge of *Population*

Perspective would help many tutors and some had apparently learned with their students.

Notably, the tutors' closing comments were generally optimistic, but tinged with the realism and insight from having been learners themselves in an implementation phase characterized by much goodwill, few resources, and administrative frustrations.

Despite not personally including triangulation in the study design, two other relevant episodes deserve mention:

- Many Semester 1 tutors engaged in reflective and useful discussion about the preliminary results of *this* study as presented by the researcher to a well-attended monthly tutor development meeting in May.
- An evaluation undertaken by Professor Tony Dixon (General Practice, University of Hong Kong; formerly of McMaster) of PBL in Liverpool's foundation Semester 1 produced results consistent with *this* study[188]. In a 1-week visit in January, he used direct observation of six tutorial sessions; interviews with students, tutors, and key curricular staff; and examination of curricular materials/documentation. In a positive report, he noted that the tutor role was still being explored and developed, with understandable uncertainties about the nature of tutor intervention. Tutors were noted to allow skipping or skimping over reviewing prior knowledge, covering *all* curricular themes, and planned end-of-tutorial evaluations, and to be too inactive in group process (missing 'teachable moments'). Further tutor development in group processes was recommended.

Comment

This study of foundation PBL tutors achieved its aim of exploring their conceptualizations of PBL and related issues in the 'new' problem-based undergraduate medical curriculum at Liverpool. The variability in their conceptualizations corresponds with the pockets of greatest semantic and philosophical disharmony in the relevant literature. Such is also consistent with the epistemological upheaval required to commit to PBL in this hitherto traditional setting (to make more than a cosmetic response to the General Medical Council's *Tomorrow's Doctors* recommendations[1]).

Tutors' views diverged most on the more profound aspects of PBL and on complex related issues. The nature of problem-solving, and the way that fallible notions of 'hard science versus the rest' bedevilled the curricular themes, for example, generated particularly superficial and/or confused responses from some tutors. Flaws in many tutors' conceptual framework for guiding public health education should not be insurmountable.

This study suggested that tutors were not engaging in the subversive language games that can cause the failure of curricular reform (as noted by Schwartz concerning the Otago failure[134,189]). They were merely making their way through PBL conceptual fog (while struggling with old intellectual baggage). They were mostly still engaging with and learning from the experience. As noted by Margetson, PBL was never

intended to be a 'quick fix'[16], and revolutionary reform will now need consolidating with evolutionary reform.

The local educational implications of this discourse are that staff development should take account of the issues that this highly motivated group of tutors apparently found particularly difficult, e.g. in:

- reconciling mixed messages about PBL and its relationship to problem-solving (conflicts need recognizing where these exist);
- facilitating group process;
- framing *all* curricular themes adequately to provide balanced interventions;
- realizing opportunities to share good practice.

Further work is needed in linking some of the related yet unsynthesized parts of the literature on PBL, problem-solving (critical thinking; clinical reasoning), knowledge, competence, and (medical) professionalism, generally. More research could usefully be undertaken on the PBL tutor concerning, for example, their:

- epistemological development (and appropriate use of 'subject' expertise);
- status as a role model.

The foundation PBL tutor proved to be a rich and under-researched source of conceptual catalyst in attempting to make sense of a compartmentalized literature.

> *"[The PBL tutors] set the stage for learning and present themselves as models of the learning process. In so doing, they exercise an unprecedented and unparalleled influence on students. PBL sessions reflect the tutor's imagination, creativity, personality, and temperament. These sessions succeed or fail in direct proportion to the tutor's preparedness and training for the task, organizational abilities, interpersonal skills, and sensitivity to students."*
>
> Mayo, Donnelly, and Schwartz, 1995[190(p126)]

Appendices

Appendix 1: Semi-structured interview schedule from problem-based learning (PBL) tutor study

From my letter, you will realize that this project is for a Master of Education dissertation. Now that there is practical experience locally of problem-based learning (PBL) tutoring, it seems timely to explore how the first tutors to assume these roles have conceptualized the PBL process (both as *method* and *philosophy*). I will record, if I may, the core of this 15-20 minute interview (to supplement my written notes after this telephone call). The tape will then be erased for use in subsequent interviews. Your responses *will* be treated in confidence. There are 3 main groups of questions, followed by a check on some background details.

Starting with the **first main heading - PBL**...

1. What, **for you**, are *the* essential characteristics of PBL? ...anything else?	**a)**	
◗ How has *your* view of PBL changed (if at *all*) since you started as a PBL tutor?	**b)i)** Changed? Yes/No/Unsure	
◗ ...and why?	**b)ii)**	
◗ How do you think that *your* view of PBL compares with: ◗ that of the other first semester PBL tutors?	**c)i)**	
◗ that conveyed to you by the Faculty of Medicine, e.g. via written materials about the curriculum; via the tutor training programmes, etc.?	**c)ii)**	
◗ that of your Semester 1 group of students?	**c)iii)**	
◗ Why did you 'volunteer' to be a PBL tutor?	**d)**	
◗ Has the PBL tutoring experience matched your expectations?	**e)** Yes/No/Unsure	
◗ What makes a good PBL tutor? It might help to focus on your 'main 3 elements'. *(**Prompt**: ...i.e. in this curriculum... integral to tutor)*	**f)**	
◗ For PBL, then, what do *you* see as its: ◗ main advantage?	**g)i)**	
◗ main disadvantage?	**g)ii)**	

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Turning briefly to the **second main heading - problem-solving**...

2. What do **you** understand by the term problem-solving skills?	**a)**	
Do you think that problem-solving skills: • can be taught?	**b)i)** Yes/No/Unsure	
• are transferable? *(**Prompt**: ...i.e. can be applied in situations other than those in which they are learnt; ...are generalizable)* (...what do you mean by transferable?) (...to what extent?)	**b)ii)** Yes/No/Unsure	
How does 'problem-solving' per se fit into your view of PBL? **[...recap on his/her view of *"the essential characteristics of PBL"* from Q1]**	**c)**	

Considering the **third main heading - the curriculum themes**...

3. In your view, what are *the* essential differences between the 4 curricular themes, – *Structure & function (S&F)*, – *Individuals, Groups & Society (IG&S)*, – *Population perspective (PP)*, – *Professional values & personal growth (PV&PG)*? *(**Prompt**: ...e.g. content, underpinning philosophy, nature of 'knowledge', 'attitudes', 'skills' required, etc.)*	**a)**	
Given these differences between the themes: • what implications (if *any*) do you consider them to have for the use of PBL?	**b)i)** Implications? Yes/No/Unsure	
• and given differences in the disciplinary backgrounds of tutors, what implications (if *any*) do you envisage for the *balance* of 'interventions' (by the tutor in group process) across all four themes?	**b)ii)** Implications? Yes/No/Unsure	

That covers the 3 main topics that I wanted to focus on...

4. Have you anything further to say about PBL as a *guiding philosophy* for the curriculum?		

Lastly, I need to check **some basic details to help me to account for differences between tutors**...

Department/other:	No. of tutorials attended? (n=21)
Discipline: Full-time/Part-time	Previous work experience of PBL?
Clinical **or** non-clinical (medical) **or** non-clinical (non-medical)	External training/education about PBL?
Post: (Medically qualified 19)	'Official' undergraduate medical teaching? years Male/Female
Academic qualifications:	Age (years): 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69

Thankyou for your help

Appendix 2: Letter from problem-based learning (PBL) tutor study

THE UNIVERSITY
of LIVERPOOL

Professor POD Pharoah
MD FFPHM MSc
Head of Department

Department of Public Health

Whelan Building
Quadrangle
Liverpool
L69 3GB
Telephone: 0151 794 5576
Facsimile: 0151 794 5588

Correspondent:
Telephone: 0151 794

5592

Monday 3rd February, 1997

Re: Master of Education (MEd) dissertation project focusing on the Semester 1 (or 'foundation') problem-based learning (PBL) tutors in the undergraduate medical curriculum

Dear

Now that we have completed this first semester of tutoring, I am informing all PBL tutor colleagues from the first cohort about a study I am undertaking (while the experience is still relatively fresh in our minds). I should be grateful if you would spare some time in the next few weeks for me to conduct **one short telephone interview with you**.

The project explores the differences in the way that the foundation group of tutors have conceptualized PBL, problem-solving, and the four curricular themes.

Your recorded responses will be treated confidentially. The results will be anonymized for presentation, and should facilitate further discussion about the Liverpool PBL tutoring process.

I hope that you will feel able to contribute to this study. It would help me greatly if you could **return the enclosed slip, in the envelope provided, as soon as possible**, indicating any times in the week that are more convenient or less convenient for you in your February schedule. If you have any outstanding queries, please get in touch or raise them with me when I ring.

Yours sincerely,

Dr Gillian Maudsley,
Senior Lecturer in Public Health Medicine

Copy for information to: *Reverend Dr David CM Taylor, Senior Tutor, Faculty of Medicine*

GM 1997

Appendix 3: Reply-slip from problem-based learning (PBL) tutor study

Tutor no.

To: Dr Gillian Maudsley, Department of Public Health, Whelan Building, Quadrangle, The University of Liverpool, Liverpool L69 3GB

Re: AVAILABILITY for brief telephone interview: *Master of Education (MEd) dissertation project about Semester 1 ('foundation') problem-based learning (PBL) tutors in the undergraduate medical curriculum*

Concerning my February schedule, my:

• most convenient times/dates are:	
• least convenient times/dates are:	
• other comments are:	

Signed:		**Name:** (Block capitals)	
Date:			

Tutor no.

To: Dr Gillian Maudsley, Department of Public Health, Whelan Building, Quadrangle, The University of Liverpool, Liverpool L69 3GB

Re: AVAILABILITY for brief telephone interview: *Master of Education (MEd) dissertation project about Semester 1 ('foundation') problem-based learning (PBL) tutors in the undergraduate medical curriculum*

Concerning my February schedule, my:

• most convenient times/dates are:	
• least convenient times/dates are:	
• other comments are:	

Signed:		**Name:** (Block capitals)	
Date:			

Tutor no.

To: Dr Gillian Maudsley, Department of Public Health, Whelan Building, Quadrangle, The University of Liverpool, Liverpool L69 3GB

Re: AVAILABILITY for brief telephone interview: *Master of Education (MEd) dissertation project about Semester 1 ('foundation') problem-based learning (PBL) tutors in the undergraduate medical curriculum*

Concerning my February schedule, my:

• most convenient times/dates are:	
• least convenient times/dates are:	
• other comments are:	

Signed:		**Name:** (Block capitals)	
Date:			

Bibliography (numerical order)

1 General Medical Council. *Tomorrow's doctors: recommendations on undergraduate medical education.* London: General Medical Council, 1993.

2 Abelson J, Maxwell PH, Maxwell RJ. Do professions have a future? Perhaps, if they are not defensive or complacent. *British Medical Journal* 1997; 315: 382.

3 Barber B. Some problems in the sociology of the professions. *Daedalus* 1963; 92(41): 669-688.

4 Moran M, Wood B. *States, regulation and the medical profession.* [Series: Law and political change.] Buckingham: Open University Press, 1993.

5 Blane D. Health professions. **In:** Patrick DL, Scambler G, editors. *Sociology as applied to medicine.* 2nd ed. London: Baillière Tindall, 1986: 213-220.

6 Haralambos M, Holborn M. *Sociology: themes and perspectives.* 3rd ed. London: Unwin Hyman, 1990.

7 Freidson E. *Profession of medicine: a study of the sociology of applied knowledge.* Chicago: The University of Chicago Press, 1988.

8 Downie RS. Professions and professionalism. *Journal of Philosophy of Education* 1990; 24(2): 147-160.

9 Dowie J, Elstein A. Editors' preface. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: xv-xvi.

10 Calman KC, Downie RS. Education and training in medicine. *Medical Education* 1988; 22: 488-491.

11 Haas J, Shaffir W. Ritual evaluation of competence: the hidden curriculum of professionalization in an innovative medical school program. *Work and Occupations* 1982; 9(2): 131-154.

[12]Becker HS, Geer B, Hughes EC, Strauss AL. *Boys in white: student culture in medical school.* New Brunswick (New Jersey): Transaction Books, 1961.

[13]Boud D, Feletti GI. Introduction. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 13-20.

[14]Barnett R. *The limits of competence: knowledge, higher education and society.* Buckingham: The Society for Research into Higher Education, 1994.

[15]White KL, Connelly JE. Preface. **In:** White KL, Connelly JE, editors. *The medical school's mission and the population's health: medical education in Canada, the United Kingdom, the United States, and Australia.* Proceedings of a conference by the Royal Society of Medicine Foundation, Inc., and the Josiah Macy Junior Foundation; 1990 Dec 9-12, Turnberry Isle, Florida. New York: Springer Verlag, 1992: vii-viii.

[16]Margetson D. Current educational reform and the significance of problem-based learning. *Studies in Higher Education* 1994; 19(1): 5-19.

[17]Benjamin H. The saber-tooth curriculum. 1939 **In:** Hooper R, editor. The curriculum: context, design, and development. Edinburgh: Oliver & Boyd, 1971. **Cited in:** Margetson D. Current educational reform and the significance of problem-based learning. *Studies in Higher Education* 1994; 19(1): 5-19.

[18]Youngson AJ. Medical education in the later 19th century: the science take-over. *Medical Education* 1989; 23: 480-491.

[19]Hunter KM. Eating the curriculum. *Academic Medicine* 1997; 72(3): 167-172.

[20]British Medical Association. *Report of the Working Party on Medical Education.* London: British Medical Association, 1995.

[21]Madeley R. Tomorrow's Doctors. *Journal of Public Health Medicine* 1994; 16(4): 379-380.

[22]Chow SP, Dixon AS. Medical education at the University of Hong Kong: changes and challenges. *Chinese Medical Journal* 1997; 110(6): 403-407.

[23]Anonymous. The Edinburgh declaration. *Lancet* 1988; ii: 464.

[24]Biggs JSG. The pre-registration year 1983-1988. *Medical Education* 1989; 23: 526-533.

[25]Nnodim JO, Osuji CU. Comparison of medical and non-medical student attitudes to social issues in medicine. *Medical Education* 1995; 29: 273-277.

[26]Acheson R, Fee E. Introduction. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 1-14.

[27]Jefferys M, Lashof J. Preparation for public health practice: into the twenty-first century. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 314-335.

[28]Woodward A. Public health has no place in undergraduate medical education. *Journal of Public Health Medicine* 1994; 16(4): 389-392.

[29]Klein L. Widening membership... Yes, but... *The Public Health Physician* 1996; 7(4): 1-2.

[30]Dowie J, Elstein A. Introduction. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 1-41.

[31]The report of the Committee of Inquiry into the future development of the Public Health Function. *Public health in England.* London: HMSO, 1988; Cm 289.

[32]White KL, Connelly JE. The medical school's mission and the population's health. *Annals of Internal Medicine* 1991; 115(12): 968-972.

33Chappel D, Maudsley G, Bhopal R, Ibrahim S, editors (for the Heads of Academic Departments of Public Health in the United Kingdom (HOADs) following a workshop in Newcastle, in May 1996, for members of those departments). *Public health education for medical students: a guide for medical schools.* Newcastle-upon-Tyne: University of Newcastle-upon-Tyne, 1996.

34Kolb DA. *Experiential learning: experience as the source of learning and development.* Englewood Cliffs (New Jersey): Prentice Hall, 1984.

35Chalmers AF. *What is this thing called Science?* 2nd ed. Buckingham: Open University Press, 1982.

36The science of making mistakes [editorial]. *Lancet* 1995; 345: 871-872.

37Hamilton D. *Learning about education: an unfinished curriculum.* [Series: Innovations in education.] Buckingham: Open University Press, 1990.

38Holt J. *How children fail.* 2nd rev ed. London: Penguin, 1982.

39Wolf A. Can competence and knowledge mix? **In:** Burke JW, editor. *Competency-based education and training.* London: Falmer Press, 1989: 39-53.

40Blagg N, Ballinger M, Gardner R. *Somerset thinking skills course: handbook.* Oxford: Basil Blackwell/Somerset County Council, 1988.

41De Bono E. *Teaching thinking.* Harmondsworth: Pelican Books, 1978.

42Dreyfus HL, Dreyfus SE. Putting computers in their proper place: analysis versus intuition in the classroom. **In:** Sloan D, editor. *The computer in education: a critical perspective.* Columbia (New York): Teachers' College Press, 1984: 40-63.

43Eraut M. Initial teacher training and the NCVQ model. **In:** Burke JW, editor. *Competency-based education and training.* London: Falmer Press, 1989: 171-185.

---

[44]Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996.

[45]Russell. **Cited in:** d'Angelo E. The teaching of critical thinking. Amsterdam: Gruner, 1971: 6. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996.

[46]Davidson JE, Deuser R, Sternberg RJ. The role of metacognition in problem solving. **In:** Metcalfe J, Shimamura AP, editors. *Metacognition: knowing about knowing.* London: Massachusetts Institute of Technology Press, 1994: 207-226.

[47]Brookfield SD. *Developing critical thinkers: challenging adults to explore alternative ways of thinking and acting.* Milton Keynes: Open University Press, 1987.

[48]Challis M, Usherwood T, Joelsbury H. Assessing specified competences in medical undergraduate training. *Competence & Assessment* 1993; issue 22: 6-9.

[49]Fleming D. The concept of meta-competence. *Competence & Assessment* 1991; issue 16: 9-12.

[50]Mitchell L. The identification of knowledge. *Competence & Assessment* 1989; issue 7: 4-6.

[51]Hodkinson P. Professionalism and competence. **In:** Hodkinson P, Issitt M, editors. *The challenge of competence: professionalism through vocational education and training.* London: Cassell, 1995: 58-69.

[52]Ellis R. Competence in the caring professions. **In:** Ellis R, editor. *Professional competence and quality assurance in the caring professions.* London: Chapman & Hall, 1988: 43-57.

[53]Hyland T. Meta-competence, metaphysics and vocational expertise. *Competence & Assessment* 1993; issue 20: 22-24.

[54]Horwitz L. Learner autonomy: a case study. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 81-86.

[55]Nisbet J, Shucksmith J. *The seventh sense: reflections on learning to learn.* Edinburgh: Scottish Council for Research in Education, 1984.

[56]Nelson TO, Narens L. Why investigate metacognition? **In:** Metcalfe J, Shimamura AP, editors. *Metacognition: knowing about knowing.* London: Massachusetts Institute of Technology Press, 1994: 1-25.

[57]Eddy DM. Variations in physician practice: the role of uncertainty. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 45-59.

[58]Barrows HS, Tamblyn RM. *Problem-based learning: an approach to medical education.* [Series: Medical Education, volume 1.] New York: Springer Publishing Company, 1980.

[59]Schön DA. From technical rationality to reflection-in-action. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 60-77.

[60]Benner P. From novice to expert. *American Journal of Nursing* 1982; 82(3): 402-407.

[61]Knowles M. *The adult learner: a neglected species.* Houston: Gulf Publishing Company, 1990.

[62]Brew A. Unlearning through experience. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 87-96.

[63]Henry J. Meaning and practice in experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 25-37.

64Boud D, Cohen R, Walker D. Introduction: understanding learning from experience. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 1-17.

65Mouly GJ. Educational research: the art and science of investigation. Boston: Allyn & Bacon, 1978. **Cited in:** Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994: 3.

66Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994.

67Boud D. Foreword. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: xi-xiii.

68McGill I, Weil SW. Introduction. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: xix-xxi.

69McGill I, Weil SW. Continuing the dialogue: new possibilities for experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 245-272.

70Weil SW, McGill I. A framework for making sense of experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 3-24.

71Albanese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. *Academic Medicine* 1993; 68(1): 52-81.

---

[72]Fisher A. Critical thinking. **In:** Coles MJ, Robinson WD, editors. *Teaching thinking: a survey of programmes in education.* Bristol: The Bristol Press, 1989: 37-45.

[73]Coles MJ, Robinson WD. Teaching thinking: What is it? Is it possible? **In:** Coles MJ, Robinson WD, editors. *Teaching thinking: a survey of programmes in education.* Bristol: The Bristol Press, 1989: 7-22.

[74]Business & Technology Education Council (BTEC). *Core skills guidance: getting started with core skills in educational and work-based settings.* London: BTEC, 1996.

[75]City & Guilds. *Core skills: working with others, improving own learning and performance, and problem solving: levels 1, 2, 3, 4, and 5: unit specifications for use from September 1996.* London: City & Guilds, 1996.

[76]Gealy N. Development of NVQs and SVQs at higher levels. *Competence & Assessment* Compendium 1994; issue 3: 68-73.

[77]Wallas G. The art of thought. New York: Harcourt Brace, 1926. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996: 320.

[78]Bransford JD, Stein BS. The ideal problem solver: a guide for improving thinking, learning, and creativity. 2nd ed. New York: Freeman, 1993. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996: 326.

[79]Robson M. *Problem-solving in groups.* 2nd ed. Aldershot: Gower Publishing, 1993.

[80]Osborn AF. *Applied imagination: principles and procedures of creative problem solving.* 3rd rev. ed. New York: Charles Scribner's & Sons, 1963.

[81]Abercrombie MLJ. *The anatomy of judgement.* Harmondsworth: Penguin, 1960.

82James DW, Johnson ML, Venning P. Testing for learnt skill in observation and evaluation of evidence. *Lancet* 1956; ii: 379.

83Jacques D. Introduction. **In:** Jacques D. *Learning in groups.* Beckenham (Kent): Croom Helm, 1984: ix-xiii.

84Norman GR, Schmidt HG. The psychological basis of problem-based learning: a review of the evidence. *Academic Medicine* 1992; 67(9): 557-565.

85Schmidt HG. Introduction. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 9-15.

86Ryan G, Little P. Innovation in a nursing curriculum: a process of change. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 111-121.

87Cawley P. A problem-based module in mechanical engineering. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 177-185.

88Norman G. Problem-solving skills versus problem-based learning. *Pedagogue* 1989; Summer issue: 1-4.

89Barrows HS. A taxonomy of problem-based learning methods. *Medical Education* 1986; 20: 481-486.

90Barrows HS. A specific problem-based, self-directed learning method designed to teach medical problem-solving skills, and enhance knowledge retention and recall. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 16-32.

91Margetson D. Why is problem-based learning a challenge? **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 42-50.

92Young M. A curriculum for the 21st century? Towards a new basis for overcoming academic/vocational divisions. *British Journal of Educational Studies* 1993; 41(3): 203-222.

93Walton HJ, Matthews MB. Essentials of problem-based learning. [Association for the Study of Medical Education Booklet no. 23.] *Medical Education* 1989; 23: 542-558.

94Dolmans DHJM, Schmidt HG. What drives the student in problem-based learning? *Medical Education* 1994; 28(5): 372-380.

95Norman GR. Problem-solving skills, solving problems and problem-based learning. *Medical Education* 1988; 22: 279-286.

96Simon HA. The sciences of the artificial. [The Karl Compton Lectures.] Lancaster: MIT Press, 1969. **Cited in:** Walton HJ, Matthews MB. Essentials of problem-based learning. [Association for the Study of Medical Education Booklet no. 23.] *Medical Education* 1989; 23: 543 (542-558).

97Ross B. Towards a framework for problem-based curricula. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 34-41.

98Engel CE. Not just a method but a way of learning. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 23-33.

99Woods DR. *Problem-based learning: how to gain the most from PBL.* Waterdown (Ontario): Donald R Woods, 1994.

100 Vernon DTA, Blake RL. Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine* 1993; 68: 550-563.

101 Berkson L. Problem-based learning: have the expectations been met? *Academic Medicine* 1993; 68(10 Suppl): S79-S88.

102 Lowry S. *Medical education.* London: BMJ Publishing Group, 1993.

103 Wolf FM. Problem-based learning and meta-analysis: can we see the forest through the trees? *Academic Medicine* 1993; 68(7): 542-544.

104 Schmidt HG. Foundations of problem-based learning: some explanatory notes. *Medical Education* 1993; 27(5): 422-432.

105 Thompson DG, Williams RG. Barriers to the acceptance of problem-based learning in medical schools. *Studies in Higher Education* 1985; 10(2): 199-204

106 Des Marchais JE, Bureau MA, Dumais B, Pigeon G. From traditional to problem-based learning: a case report of complete curriculum reform. *Medical Education* 1992; 26: 190-199.

107 Anderson AS. Conversion to problem-based learning in 15 months. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 72-79.

108 Abdulrazzaq YM, Qayed KI. A study of the attitudes of the foundation staff of a new medical faculty to problem-based learning. *Medical Teacher* 1991; 13(4): 281-288.

109 Little SE, Sauer C. Organizational and institutional impediments to a problem-based approach. **In:** Boud D, Feletti G, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 88-95.

110 Glick SM. Problem-based learning and community-oriented medical education. *Medical Education* 1991; 25: 542-545.

111 Norman GR. Introduction. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 125-127.

112 Barrows HS, Feltovich PJ. The clinical reasoning process. *Medical Education* 1987; 21: 86-91.

113 Barrows HS, Pickell GC. *Developing clinical problem-solving skills: a guide to more effective diagnosis and treatment.* London: WW Norton, 1991.

114 Kassirer JP. Teaching clinical medicine by iterative hypothesis testing: let's preach what we practice. *New England Journal of Medicine* 1983; 309(15): 921-923.

115 Norman GR, Trott AD, Brooks LR, Smith EKM. Cognitive differences in clinical reasoning related to postgraduate training. *Teaching & Learning in Medicine* 1994; 6(2): 114-120.

116 Elstein AS. What goes around comes around: return of the hypothetico-deductive strategy. *Teaching & Learning in Medicine* 1994; 6(2): 121-123.

117 Elstein AS, Kagan N, Shulman LS, Jason H, Loupe MJ. Methods and theory in the study of medical inquiry. *Journal of Medical Education* 1972; 47: 86-92.

118 Elstein AS, Shulman LS, Sprafka SA. *Medical problem solving: an analysis of clinical reasoning.* Cambridge (Massachusetts): Harvard University Press, 1978. **Cited in:** Elstein AS. What goes around comes around: return of the hypothetico-deductive strategy. *Teaching & Learning in Medicine* 1994; 6(2): 121-123.

119 Mandin H, Jones A, Woloschuk W, Harasym P. Helping students to learn to think like experts when solving clinical problems. *Academic Medicine* 1997; 72(3): 173-179.

120 Patel VL, Groen GJ, Norman GR. Effects of conventional and problem-based medical curricula on problem solving. *Academic Medicine* 1991; 66(7): 380-389.

121 Norman GR. The role of knowledge in teaching and assessment of problem-solving. *Journal of Instructional Development* 1985; 8(1): 7-10.

122 Lewkonia RM, Harasym PH, Darwish HZ. Early introduction to medical problem-solving. *Medical Teacher* 1993; 15(1): 57-65.

123 Packham R, Roberts R, Bawden R. Our faculty goes experiential. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton

Keynes: The Society for Research into Higher Education & Open University Press, 1989: 129-149.

124 Marmot MG, Zwi AB. Measuring the burden of illness in general populations. **In:** White KL, Connelly JE, editors. *The medical school's mission and the population's health: medical education in Canada, the United Kingdom, the United States, and Australia.* Proceedings of a conference by the Royal Society of Medicine Foundation, Inc., and the Josiah Macy Junior Foundation; 1990 Dec 9-12, Turnberry Isle, Florida. New York: Springer Verlag, 1992: 60-112.

125 Stone DH. The Beer Sheva experiment and its lessons for community medicine. *Community Medicine* 1988; 10(3): 228-234.

126 Riegelman RK. Medical Student Myopia Syndrome: a recently recognized pan-epidemic. *American Journal of Preventive Medicine* 1991; 7(4): 252.

127 Massey RU. Problem-based learning: a better way? *Connecticut Medicine* 1994; 58(12): 753.

128 Fee E, Porter D. Public health, preventive medicine, and professionalization: Britain and the United States in the nineteenth century. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 15-43.

129 Fee E, Rosenkrantz B. Professional education for public health in the United States. **In:** Fee E, Acheson RM. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 230-271.

130 Almy TP, Colby KK, Zubkoff M, Gephart DS, Moore-West M, Lundquist LL. Health, society, and the physician: problem-based learning of the social sciences and humanities: eight years of experience. *Annals of Internal Medicine* 1992; 116: 569-574.

131 Taylor WC, Moore GT. Health promotion and disease prevention: integration into a medical school curriculum. *Medical Education* 1994; 28: 481-487.

132 Leinster S. The new curriculum at Liverpool. *Association of Liverpool Medical School Newsletter* 1997; 23: 3-4.

133 Vernon DTA. Attitudes and opinions of faculty tutors about problem-based learning. *Academic Medicine* 1995; 70(3): 216-223.

134 Schwartz P. Persevering with problem-based learning. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 65-71.

135 Schwartz PL, Heath CJ, Egan AG. *The art of the possible: ideas from a traditional medical school engaged in curricular revision.* Dunedin: University of Otago Press, 1994.

136 Moore GT. Initiating problem-based learning at Harvard Medical School. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 80-87.

137 Des Marchais JE. A student-centred, problem-based curriculum: 5 years' experience. *Canadian Medical Association Journal* 1993; 148(9): 1567-1572.

138 Grand'Maison P, Des Marchais JE. Preparing faculty to teach in a problem-based learning curriculum: the Sherbrooke experience. *Canadian Medical Association Journal* 1991; 144(5): 557-562.

139 Des Marchais JE. From traditional to problem-based curriculum: how the switch was made at Sherbrooke, Canada. *Lancet* 1991; 338: 234-237.

140 McDermott JF. Anderson AS. Retraining faculty for the problem-based curriculum at the University of Hawaii 1989-1991. *Academic Medicine* 1991; 66(12): 778-779.

141 David TJ, Patel L. Adult learning theory, problem based learning, and paediatrics. *Archives of Disease in Childhood* 1995; 73: 357-363.

142 Moore W. Method in the madness. [Training for doctors.] *Health Service Journal* 1996: February issue: 17-21.

143 Neufeld VR, Barrows HS. The 'McMaster philosophy': an approach to medical education. *Journal of Medical Education* 1974; 49: 1040-1050.

144 Blake JM, Norman GR, Smith EKM. Report card from McMaster: student evaluation at a problem-based medical school. *Lancet* 1995; 345: 899-902.

145 Schmidt HG, Bouhuijs PAJ. Onderwijs in taakgerichte groepen [Education in task-oriented groups.] Utrecht: Spectrum Books, 1980. **Cited in:** Foster SF, Gilbert A. Experiences with problem-based learning in management and economics. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 235 (234-241).

146 Schmidt HG. Problem-based learning, rationale and description. *Medical Education* 1993; 17: 11-16.

147 Bligh J. Problem based, small group learning: an idea whose time has come. *British Medical Journal* 1995; 311: 342-343.

148 Bligh J. Problem-based learning in medicine: an introduction. *Postgraduate Medical Journal* 1995; 71: 323-326.

149 Henry R. Identifying and responding to needs. **In:** Henry R, Byrne K, Engel C, editors. *Imperatives in medical education: the Newcastle approach.* Newcastle (Australia): The University of Newcastle Faculty of Medicine & Health Sciences, 1997: 4-10.

150 McPherson J. Design and implementation of the curriculum. **In:** Henry R, Byrne K, Engel C, editors. *Imperatives in medical education: the Newcastle approach.* Newcastle (Australia): The University of Newcastle Faculty of Medicine & Health Sciences, 1997: 11-17.

151 Friedman CP, de Bliek R, Greer DS, Mennin SP, Norman GR, Sheps CG, et al. Charting the winds of change: evaluating innovative medical curricula. *Academic Medicine* 1990; 65(1): 8-14.

152 McMaster Education Services. *"...So you are going to be a tutor: a brief guide."* Hamilton (Ontario): McMaster University, 1994.

153 Moust JHC. *The Maastricht tutor role.* Maastricht: The University of Limburg, Department of Educational Development & Research, 1993.

154 Evans PA, Taylor DCM. *Staff development of tutor skills for problem-based learning.* Medical Education 1996; 30(5): 365-366.

155 Wilkerson L, Hundert EM. Becoming a problem-based tutor: increasing self-awareness through faculty development. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 159-171.

156 Wilkerson L. Faculty development. **In:** Tosteson DC, Adelstein SJ, Carver ST, editors. *New pathways to medical education: learning to learn at Harvard Medical School.* Cambridge (Massachusetts): Harvard University Press, 1994: 79-99.

157 Taylor D. *Personal development.* Paper at 'Transition from medical student to medical practitioner' Association for Medical Education conference 16-18.7.97 Cambridge: 14-15.

158 Kinderman P, Humphris G. Clinical communication skills teaching: the role of cognitive schemata. *Medical Education* 1995; 29(6):436-442.

159 Faculty of Medicine. *New curriculum: MB ChB course handbook, 1996/97.* Liverpool: The University of Liverpool, 1996.

160 Meadows H, Taylor D. *The new medical course at The University of Liverpool: a guide for first year students.* Liverpool: The University of Liverpool, Faculty of Medicine, Medical Education Unit, 1996.

161 Taylor D. *Guide for PBL tutors.* Liverpool: The University of Liverpool, Faculty of Medicine, Medical Education Unit, 1996.

162 Brookfield S. Through the lens of learning: how the visceral experience of learning reframes teaching. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 21-32.

163 Neame RLB. Problem-centred learning in medical education: the role of context in the development of process skills. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 33-47.

164 Perry WG Jr. *Forms of intellectual and ethical development in the college years: a scheme.* New York: Holt Rinehart & Winston, 1970.

165 Centeno AM. Praise for problem-based learning [letter]. *Postgraduate Medicine* 1990; 88(4): 34.

166 Andresen L. On becoming a maker of teachers: journey down a long hall of mirrors. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 59-70.

167 Silver M, Wilkerson L. Effects of tutors with subject expertise on the problem-based tutorial process. *Academic Medicine* 1991; 66(5): 298-300.

168 Whipple WR. Collaborative learning: recognizing it when we see it. *American Association Higher Education Bulletin* 1987; 40: 3-6.

169Tipping J, Freeman RF, Rachlis AR. Using faculty and student perceptions of group dynamics to develop recommendations for PBL training. *Academic Medicine* 1995; 70(11): 1050-1052.

170Wilkerson L, Hafler JP, Liu PA. Case study of student-directed discussion in four problem-based tutorial groups. In: Research in Medical Education: Proceedings of the Thirtieth Annual Conference. *Academic Medicine* 1991; 66: S79-S81.

171Eagle CJ, Harasym PH, Mandin H. Effects of tutors with case expertise on problem-based learning issues. *Academic Medicine* 1992; 67(7): 465-469.

172Davis WK, Nairn R, Paine ME, Anderson RM, OH MS. Effects of expert and non-expert facilitators on small-group process and on student performance. *Academic Medicine* 1992; 67: 470-474.

173Schmidt HG, van der Arend A, Moust JHC, Kokx I, Boon L. Influence of tutors' subject-matter expertise on student effort and achievement in problem-based learning. *Academic Medicine* 1993; 68(10): 784-791.

174Schmidt HG, Moust JHC. What makes a tutor effective? A structural-equations modeling approach to learning in problem-based curricula. *Academic Medicine* 1995; 70(8): 708-714.

175de Volder ML. *Discussion groups and their tutors: relationships between tutor characteristics and tutor functioning.* Higher Education 1982; 11: 269-271.

176Schmidt HG. Resolving inconsistencies in tutor expertise research: does lack of structure cause students to seek tutor guidance? *Academic Medicine* 1994; 69(8): 656-662.

177Kaufman DM, Holmes DB. Tutoring in problem-based learning: perceptions of teachers and students. *Medical Education* 1996; 30(5): 371-377.

178Vernon DTA. Tutor evaluation of problem-based learning in behavioural sciences courses. *Teaching & Learning in Medicine* 1994; 6: 91-95.

179 Lucero SM, Jackson R, Galey WR. Tutorial groups in problem-based learning. **In:** Kaufman A, editor. *Implementing problem-based medical education: lessons from successful innovations.* [Series: Medical Education, volume 9.] New York: Springer, 1985: 45-70.

180 Wilkerson L, Maxwell JA. A qualitative study of initial faculty tutors in a problem-based curriculum. *Journal of Medical Education* 1988; 63: 892-899.

181 Burrell G, Morgan G. Sociological paradigms and organisational analysis. London: Heinemann Educational Books. **Cited in:** Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994: 9 (1-43), 388.

182 Bogdan RC, Biklen SK. *Qualitative research for education: an introduction to theory and methods.* Boston (Massachusetts): Allyn & Bacon, 1982.

183 Krueger RA. *Focus groups: a practical guide for applied research.* 2nd ed. London: Sage Publications, 1994.

184 Dolmans DHJM, Wolfhagen IHAP, van der Vleuten CPM. Long-term stability of tutor performance. *Academic Medicine* 1996; 71(12): 1344-1347.

185 Riley J. *Getting the most from your data: a handbook of practical ideas on how to analyse qualitative data.* [Series: Interesting ways to teach.] 2nd ed. Bristol: Technical and Educational Services, 1996.

186 Bernstein P, Tipping J, Bercovitz K, Skinner HA. Shifting students and faculty to a PBL curriculum: attitudes changed and lessons learned. *Academic Medicine* 1995; 70(3): 245-247.

187 Cornwell J. *Hard-earned lives: accounts of health and illness from East London.* London: Tavistock, 1984.

188 Dixon T. *Report on visit to Liverpool Medical School.* Hong Kong: Faculty of Medicine Hong Kong, 1997. [with permission - Faculty of Medicine]

189 Pitman A. The necessary distortion of disseminated innovations. *Journal of Curriculum Studies* 1981; 13(3): 253-256.

190 Mayo WP, Donnelly MB, Schwartz RW. Characteristics of the ideal problem-based learning tutor in clinical medicine. *Evaluation and the health professions* 1995; 18(2): 124-136.

Bibliography (alphabetical order)

Abdulrazzaq YM, Qayed KI. A study of the attitudes of the foundation staff of a new medical faculty to problem-based learning. *Medical Teacher* 1991; 13(4): 281-288.

Abelson J, Maxwell PH, Maxwell RJ. Do professions have a future? Perhaps, if they are not defensive or complacent. *British Medical Journal* 1997; 315: 382.

Abercrombie MLJ. *The anatomy of judgement.* Harmondsworth: Penguin, 1960.

Acheson R, Fee E. Introduction. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 1-14.

Albanese MA, Mitchell S. Problem-based learning: a review of literature on its outcomes and implementation issues. *Academic Medicine* 1993; 68(1): 52-81.

Almy TP, Colby KK, Zubkoff M, Gephart DS, Moore-West M, Lundquist LL. Health, society, and the physician: problem-based learning of the social sciences and humanities: eight years of experience. *Annals of Internal Medicine* 1992; 116: 569-574.

Anderson AS. Conversion to problem-based learning in 15 months. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 72-79.

Andresen L. On becoming a maker of teachers: journey down a long hall of mirrors. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 59-70.

Anonymous. The Edinburgh declaration. *Lancet* 1988; ii: 464.

Barber B. Some problems in the sociology of the professions. *Daedalus* 1963; 92(41): 669-688.

Barnett R. *The limits of competence: knowledge, higher education and society.* Buckingham: The Society for Research into Higher Education, 1994.

Barrows HS, Feltovich PJ. The clinical reasoning process. *Medical Education* 1987; 21: 86-91.

Barrows HS, Pickell GC. *Developing clinical problem-solving skills: a guide to more effective diagnosis and treatment.* London: WW Norton, 1991.

Barrows HS, Tamblyn RM. *Problem-based learning: an approach to medical education.* [Series: Medical Education, volume 1.] New York: Springer Publishing Company, 1980.

Barrows HS. A specific problem-based, self-directed learning method designed to teach medical problem-solving skills, and enhance knowledge retention and recall. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 16-32.

Barrows HS. A taxonomy of problem-based learning methods. *Medical Education* 1986; 20: 481-486.

Becker HS, Geer B, Hughes EC, Strauss AL. *Boys in white: student culture in medical school.* New Brunswick (New Jersey): Transaction Books, 1961.

Benjamin H. The saber-tooth curriculum. 1939 **In:** Hooper R, editor. The curriculum: context, design, and development. Edinburgh: Oliver & Boyd, 1971. **Cited in:** Margetson D. Current educational reform and the significance of problem-based learning. *Studies in Higher Education* 1994; 19(1): 5-19.

Benner P. From novice to expert. *American Journal of Nursing* 1982; 82(3): 402-407.

Berkson L. Problem-based learning: have the expectations been met? *Academic Medicine* 1993; 68(10 Suppl): S79-S88.

Bernstein P, Tipping J, Bercovitz K, Skinner HA. Shifting students and faculty to a PBL curriculum: attitudes changed and lessons learned. *Academic Medicine* 1995; 70(3): 245-247.

Biggs JSG. The pre-registration year 1983-1988. *Medical Education* 1989; 23: 526-533.

Blagg N, Ballinger M, Gardner R. *Somerset thinking skills course: handbook.* Oxford: Basil Blackwell/Somerset County Council, 1988.

Blake JM, Norman GR, Smith EKM. Report card from McMaster: student evaluation at a problem-based medical school. *Lancet* 1995; 345: 899-902.

Blane D. Health professions. **In:** Patrick DL, Scambler G, editors. *Sociology as applied to medicine.* 2nd ed. London: Baillière Tindall, 1986: 213-220.

Bligh J. Problem based, small group learning: an idea whose time has come. *British Medical Journal* 1995; 311: 342-343.

Bligh J. Problem-based learning in medicine: an introduction. *Postgraduate Medical Journal* 1995; 71: 323-326.

Bogdan RC, Biklen SK. *Qualitative research for education: an introduction to theory and methods.* Boston (Massachusetts): Allyn & Bacon, 1982.

Boud D, Cohen R, Walker D. Introduction: understanding learning from experience. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 1-17.

Boud D, Feletti GI. Introduction. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 13-20.

Boud D. Foreword. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: xi-xiii.

Bransford JD, Stein BS. The ideal problem solver: a guide for improving thinking, learning, and creativity. 2nd ed. New York: Freeman, 1993. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996: 326.

Brew A. Unlearning through experience. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 87-96.

British Medical Association. *Report of the Working Party on Medical Education.* London: British Medical Association, 1995.

Brookfield S. Through the lens of learning: how the visceral experience of learning reframes teaching. **In:** Boud D, Cohen R, Walker D, editors. *Using experience for learning.* Buckingham: The Society for Research into Higher Education & Open University Press, 1993: 21-32.

Brookfield SD. *Developing critical thinkers: challenging adults to explore alternative ways of thinking and acting.* Milton Keynes: Open University Press, 1987.

Burrell G, Morgan G. Sociological paradigms and organisational analysis. London: Heinemann Educational Books. **Cited in:** Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994: 9 (1-43), 388.

Business & Technology Education Council (BTEC). *Core skills guidance: getting started with core skills in educational and work-based settings.* London: BTEC, 1996.

Calman KC, Downie RS. Education and training in medicine. *Medical Education* 1988; 22: 488-491.

Cawley P. A problem-based module in mechanical engineering. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 177-185.

Centeno AM. Praise for problem-based learning [letter]. *Postgraduate Medicine* 1990; 88(4): 34.

Challis M, Usherwood T, Joelsbury H. Assessing specified competences in medical undergraduate training. *Competence & Assessment* 1993; issue 22: 6-9.

Chalmers AF. *What is this thing called Science?* 2nd ed. Buckingham: Open University Press, 1982.

Chappel D, Maudsley G, Bhopal R, Ibrahim S, editors (for the Heads of Academic Departments of Public Health in the United Kingdom (HOADs) following a workshop in Newcastle, in May 1996, for members of those departments). *Public health education for medical students: a guide for medical schools.* Newcastle-upon-Tyne: University of Newcastle-upon-Tyne, 1996.

Chow SP, Dixon AS. Medical education at the University of Hong Kong: changes and challenges. *Chinese Medical Journal* 1997; 110(6): 403-407.

City & Guilds. *Core skills: working with others, improving own learning and performance, and problem solving: levels 1, 2, 3, 4, and 5: unit specifications for use from September 1996.* London: City & Guilds, 1996.

Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994.

Coles MJ, Robinson WD. Teaching thinking: What is it? Is it possible? **In:** Coles MJ, Robinson WD, editors. *Teaching thinking: a survey of programmes in education.* Bristol: The Bristol Press, 1989: 7-22.

Cornwell J. *Hard-earned lives: accounts of health and illness from East London.* London: Tavistock, 1984.

David TJ, Patel L. Adult learning theory, problem based learning, and paediatrics. *Archives of Disease in Childhood* 1995; 73: 357-363.

Davidson JE, Deuser R, Sternberg RJ. The role of metacognition in problem solving. **In:** Metcalfe J, Shimamura AP, editors. *Metacognition: knowing about knowing.* London: Massachusetts Institute of Technology Press, 1994: 207-226.

Davis WK, Nairn R, Paine ME, Anderson RM, OH MS. Effects of expert and non-expert facilitators on small-group process and on student performance. *Academic Medicine* 1992; 67: 470-474.

De Bono E. *Teaching thinking.* Harmondsworth: Pelican Books, 1978.

de Volder ML. *Discussion groups and their tutors: relationships between tutor characteristics and tutor functioning.* Higher Education 1982; 11: 269-271.

Des Marchais JE, Bureau MA, Dumais B, Pigeon G. From traditional to problem-based learning: a case report of complete curriculum reform. *Medical Education* 1992; 26: 190-199.

Des Marchais JE. A student-centred, problem-based curriculum: 5 years' experience. *Canadian Medical Association Journal* 1993; 148(9): 1567-1572.

Des Marchais JE. From traditional to problem-based curriculum: how the switch was made at Sherbrooke, Canada. *Lancet* 1991; 338: 234-237.

Dixon T. *Report on visit to Liverpool Medical School.* Hong Kong: Faculty of Medicine Hong Kong, 1997. [with permission - Faculty of Medicine]

Dolmans DHJM, Schmidt HG. What drives the student in problem-based learning? *Medical Education* 1994; 28(5): 372-380.

Dolmans DHJM, Wolfhagen IHAP, van der Vleuten CPM. Long-term stability of tutor performance. *Academic Medicine* 1996; 71(12): 1344-1347.

Dowie J, Elstein A. Editors' preface. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: xv-xvi.

Dowie J, Elstein A. Introduction. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 1-41.

Downie RS. Professions and professionalism. *Journal of Philosophy of Education* 1990; 24(2): 147-160.

Dreyfus HL, Dreyfus SE. Putting computers in their proper place: analysis versus intuition in the classroom. Sloan D, editor. *The computer in education: a critical perspective.* Columbia (New York): Teachers' College Press, 1984: 40-63.

Eagle CJ, Harasym PH, Mandin H. Effects of tutors with case expertise on problem-based learning issues. *Academic Medicine* 1992; 67(7): 465-469.

Eddy DM. Variations in physician practice: the role of uncertainty. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 45-59.

Ellis R. Competence in the caring professions. **In:** Ellis R, editor. *Professional competence and quality assurance in the caring professions.* London: Chapman & Hall, 1988: 43-57.

Elstein AS, Kagan N, Shulman LS, Jason H, Loupe MJ. Methods and theory in the study of medical inquiry. *Journal of Medical Education* 1972; 47: 86-92.

Elstein AS, Shulman LS, Sprafka SA. *Medical problem solving: an analysis of clinical reasoning.* Cambridge (Massachusetts): Harvard University Press, 1978. **Cited in:** Elstein AS. What goes around comes around: return of the hypothetico-deductive strategy. *Teaching & Learning in Medicine* 1994; 6(2): 121-123.

Elstein AS. What goes around comes around: return of the hypothetico-deductive strategy. *Teaching & Learning in Medicine* 1994; 6(2): 121-123.

Engel CE. Not just a method but a way of learning. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 23-33.

Eraut M. Initial teacher training and the NCVQ model. **In:** Burke JW, editor. *Competency-based education and training.* London: Falmer Press, 1989: 171-185.

Evans PA, Taylor DCM. *Staff development of tutor skills for problem-based learning.* Medical Education 1996; 30(5): 365-366.

Faculty of Medicine. *New curriculum: MB ChB course handbook, 1996/97.* Liverpool: The University of Liverpool, 1996.

Fee E, Porter D. Public health, preventive medicine, and professionalization: Britain and the United States in the nineteenth century. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 15-43.

Fee E, Rosenkrantz B. Professional education for public health in the United States. **In:** Fee E, Acheson RM. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 230-271.

Fisher A. Critical thinking. **In:** Coles MJ, Robinson WD, editors. *Teaching thinking: a survey of programmes in education.* Bristol: The Bristol Press, 1989: 37-45.

Fleming D. The concept of meta-competence. *Competence & Assessment* 1991; issue 16: 9-12.

Freidson E. *Profession of medicine: a study of the sociology of applied knowledge.* Chicago: The University of Chicago Press, 1988.

Friedman CP, de Bliek R, Greer DS, Mennin SP, Norman GR, Sheps CG, et al. Charting the winds of change: evaluating innovative medical curricula. *Academic Medicine* 1990; 65(1): 8-14.

Gealy N. Development of NVQs and SVQs at higher levels. *Competence & Assessment* Compendium 1994; issue 3: 68-73.

General Medical Council. *Tomorrow's doctors: recommendations on undergraduate medical education.* London: General Medical Council, 1993.

Glick SM. Problem-based learning and community-oriented medical education. *Medical Education* 1991; 25: 542-545.

Grand'Maison P, Des Marchais JE. Preparing faculty to teach in a problem-based learning curriculum: the Sherbrooke experience. *Canadian Medical Association Journal* 1991; 144(5): 557-562.

Haas J, Shaffir W. Ritual evaluation of competence: the hidden curriculum of professionalization in an innovative medical school program. *Work and Occupations* 1982; 9(2): 131-154.

Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996.

Hamilton D. *Learning about education: an unfinished curriculum.* [Series: Innovations in education.] Buckingham: Open University Press, 1990.

Haralambos M, Holborn M. *Sociology: themes and perspectives.* 3rd ed. London: Unwin Hyman, 1990.

Henry J. Meaning and practice in experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 25-37.

Henry R. Identifying and responding to needs. **In:** Henry R, Byrne K, Engel C, editors. *Imperatives in medical education: the Newcastle approach.* Newcastle (Australia): The University of Newcastle Faculty of Medicine & Health Sciences, 1997: 4-10.

Hodkinson P. Professionalism and competence. **In:** Hodkinson P, Issitt M, editors. *The challenge of competence: professionalism through vocational education and training.* London: Cassell, 1995: 58-69.

Holt J. *How children fail.* 2nd rev ed. London: Penguin, 1982.

Horwitz L. Learner autonomy: a case study. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 81-86.

Hunter KM. Eating the curriculum. *Academic Medicine* 1997; 72(3): 167-172.

Hyland T. Meta-competence, metaphysics and vocational expertise. *Competence & Assessment* 1993; issue 20: 22-24.

Jacques D. Introduction. **In:** Jacques D. *Learning in groups.* Beckenham (Kent): Croom Helm, 1984: ix-xiii.

James DW, Johnson ML, Venning P. Testing for learnt skill in observation and evaluation of evidence. *Lancet* 1956; ii: 379.

Jefferys M, Lashof J. Preparation for public health practice: into the twenty-first century. **In:** Fee E, Acheson RM, editors. *A history of education in public health: health that mocks the doctors' rules.* Oxford: Oxford University Press, 1991: 314-335.

Kassirer JP. Teaching clinical medicine by iterative hypothesis testing: let's preach what we practice. *New England Journal of Medicine* 1983; 309(15): 921-923.

Kaufman DM, Holmes DB. Tutoring in problem-based learning: perceptions of teachers and students. *Medical Education* 1996; 30(5): 371-377.

Kinderman P, Humphris G. Clinical communication skills teaching: the role of cognitive schemata. *Medical Education* 1995; 29(6):436-442.

Klein L. Widening membership... Yes, but... *The Public Health Physician* 1996; 7(4): 1-2.

Knowles M. *The adult learner: a neglected species.* Houston: Gulf Publishing Company, 1990.

Kolb DA. *Experiential learning: experience as the source of learning and development.* Englewood Cliffs (New Jersey): Prentice Hall, 1984.

Krueger RA. *Focus groups: a practical guide for applied research.* 2nd ed. London: Sage Publications, 1994.

Leinster S. The new curriculum at Liverpool. *Association of Liverpool Medical School Newsletter* 1997; 23: 3-4.

Lewkonia RM, Harasym PH, Darwish HZ. Early introduction to medical problem-solving. *Medical Teacher* 1993; 15(1): 57-65.

Little SE, Sauer C. Organizational and institutional impediments to a problem-based approach. **In:** Boud D, Feletti G, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 88-95.

Lowry S. *Medical education.* London: BMJ Publishing Group, 1993.

Lucero SM, Jackson R, Galey WR. Tutorial groups in problem-based learning. **In:** Kaufman A, editor. *Implementing problem-based medical education: lessons from successful innovations.* [Series: Medical Education, volume 9.] New York: Springer, 1985: 45-70.

Madeley R. Tomorrow's Doctors. *Journal of Public Health Medicine* 1994; 16(4): 379-380.

Mandin H, Jones A, Woloschuk W, Harasym P. Helping students to learn to think like experts when solving clinical problems. *Academic Medicine* 1997; 72(3): 173-179.

Margetson D. Current educational reform and the significance of problem-based learning. *Studies in Higher Education* 1994; 19(1): 5-19.

Margetson D. Why is problem-based learning a challenge? **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 42-50.

Marmot MG, Zwi AB. Measuring the burden of illness in general populations. **In:** White KL, Connelly JE, editors. *The medical school's mission and the population's health: medical education in Canada, the United Kingdom, the United States, and Australia.* Proceedings of a conference by the Royal Society of Medicine Foundation, Inc., and the Josiah Macy Junior Foundation; 1990 Dec 9-12, Turnberry Isle, Florida. New York: Springer Verlag, 1992: 60-112.

Massey RU. Problem-based learning: a better way? *Connecticut Medicine* 1994; 58(12): 753.

Mayo WP, Donnelly MB, Schwartz RW. Characteristics of the ideal problem-based learning tutor in clinical medicine. *Evaluation and the health professions* 1995; 18(2): 124-136.

McDermott JF. Anderson AS. Retraining faculty for the problem-based curriculum at the University of Hawaii 1989-1991. *Academic Medicine* 1991; 66(12): 778-779.

McGill I, Weil SW. Continuing the dialogue: new possibilities for experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 245-272.

McGill I, Weil SW. Introduction. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: xix-xxi.

McMaster Education Services. *"...So you are going to be a tutor: a brief guide."* Hamilton (Ontario): McMaster University, 1994.

McPherson J. Design and implementation of the curriculum. **In:** Henry R, Byrne K, Engel C, editors. *Imperatives in medical education: the Newcastle approach.* Newcastle (Australia): The University of Newcastle Faculty of Medicine & Health Sciences, 1997: 11-17.

Meadows H, Taylor D. *The new medical course at The University of Liverpool: a guide for first year students.* Liverpool: The University of Liverpool, Faculty of Medicine, Medical Education Unit, 1996.

Mitchell L. The identification of knowledge. *Competence & Assessment* 1989; issue 7: 4-6.

Moore GT. Initiating problem-based learning at Harvard Medical School. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 80-87.

Moore W. Method in the madness. [Training for doctors.] *Health Service Journal* 1996: February issue: 17-21.

Moran M, Wood B. *States, regulation and the medical profession.* [Series: Law and political change.] Buckingham: Open University Press, 1993.

Mouly GJ. Educational research: the art and science of investigation. Boston: Allyn & Bacon, 1978. **Cited in:** Cohen L, Manion L. *Research methods in education.* 4th ed. London: Routledge, 1994: 3.

Moust JHC. *The Maastricht tutor role.* Maastricht: The University of Limburg, Department of Educational Development & Research, 1993.

Neame RLB. Problem-centred learning in medical education: the role of context in the development of process skills. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 33-47.

Nelson TO, Narens L. Why investigate metacognition? **In:** Metcalfe J, Shimamura AP, editors. *Metacognition: knowing about knowing.* London: Massachusetts Institute of Technology Press, 1994: 1-25.

Neufeld VR, Barrows HS. The 'McMaster philosophy': an approach to medical education. *Journal of Medical Education* 1974; 49: 1040-1050.

Nisbet J, Shucksmith J. *The seventh sense: reflections on learning to learn.* Edinburgh: Scottish Council for Research in Education, 1984.

Nnodim JO, Osuji CU. Comparison of medical and non-medical student attitudes to social issues in medicine. *Medical Education* 1995; 29: 273-277.

Norman G. Problem-solving skills versus problem-based learning. *Pedagogue* 1989; Summer issue: 1-4.

Norman GR, Schmidt HG. The psychological basis of problem-based learning: a review of the evidence. *Academic Medicine* 1992; 67(9): 557-565.

Norman GR, Trott AD, Brooks LR, Smith EKM. Cognitive differences in clinical reasoning related to postgraduate training. *Teaching & Learning in Medicine* 1994; 6(2): 114-120.

Norman GR. Introduction. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 125-127.

Norman GR. Problem-solving skills, solving problems and problem-based learning. *Medical Education* 1988; 22: 279-286.

Norman GR. The role of knowledge in teaching and assessment of problem-solving. *Journal of Instructional Development* 1985; 8(1): 7-10.

Osborn AF. *Applied imagination: principles and procedures of creative problem solving.* 3rd rev. ed. New York: Charles Scribner's & Sons, 1963.

Packham R, Roberts R, Bawden R. Our faculty goes experiential. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 129-149.

Patel VL, Groen GJ, Norman GR. Effects of conventional and problem-based medical curricula on problem solving. *Academic Medicine* 1991; 66(7): 380-389.

Perry WG Jr. *Forms of intellectual and ethical development in the college years: a scheme.* New York: Holt Rinehart & Winston, 1970.

Pitman A. The necessary distortion of disseminated innovations. *Journal of Curriculum Studies* 1981; 13(3): 253-256.

Riegelman RK. Medical Student Myopia Syndrome: a recently recognized pan-epidemic. *American Journal of Preventive Medicine* 1991; 7(4): 252.

Riley J. *Getting the most from your data: a handbook of practical ideas on how to analyse qualitative data.* [Series: Interesting ways to teach.] 2nd ed. Bristol: Technical and Educational Services, 1996.

Robson M. *Problem-solving in groups.* 2nd ed. Aldershot: Gower Publishing, 1993.

Ross B. Towards a framework for problem-based curricula. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 34-41.

Russell. **Cited in:** d'Angelo E. The teaching of critical thinking. Amsterdam: Gruner, 1971: 6. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996.

Ryan G, Little P. Innovation in a nursing curriculum: a process of change. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 111-121.

Schön DA. From technical rationality to reflection-in-action. **In:** Dowie J, Elstein A, editors. *Professional judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press, 1988: 60-77.

Schmidt HG, Bouhuijs PAJ. Onderwijs in taakgerichte groepen [Education in task-oriented groups.] Utrecht: Spectrum Books, 1980. **Cited in:** Foster SF, Gilbert A. Experiences with problem-based learning in management and economics. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 235 (234-241).

Schmidt HG, Moust JHC. What makes a tutor effective? A structural-equations modeling approach to learning in problem-based curricula. *Academic Medicine* 1995; 70(8): 708-714.

Schmidt HG, van der Arend A, Moust JHC, Kokx I, Boon L. Influence of tutors' subject-matter expertise on student effort and achievement in problem-based learning. *Academic Medicine* 1993; 68(10): 784-791.

Schmidt HG. Foundations of problem-based learning: some explanatory notes. *Medical Education* 1993; 27(5): 422-432.

Schmidt HG. Introduction. **In:** Schmidt HG, de Volder ML, editors. *Tutorials in problem-based learning: a new direction in teaching the health professions.* Assen (Maastricht): van Gorcum, 1984: 9-15.

Schmidt HG. Problem-based learning, rationale and description. *Medical Education* 1993; 17: 11-16.

Schmidt HG. Resolving inconsistencies in tutor expertise research: does lack of structure cause students to seek tutor guidance? *Academic Medicine* 1994; 69(8): 656-662.

Schwartz P. Persevering with problem-based learning. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 65-71.

Schwartz PL, Heath CJ, Egan AG. *The art of the possible: ideas from a traditional medical school engaged in curricular revision.* Dunedin: University of Otago Press, 1994.

Silver M, Wilkerson L. Effects of tutors with subject expertise on the problem-based tutorial process. *Academic Medicine* 1991; 66(5): 298-300.

Simon HA. The sciences of the artificial. [The Karl Compton Lectures.] Lancaster: MIT Press, 1969. **Cited in:** Walton HJ, Matthews MB. Essentials of problem-based learning. [Association for the Study of Medical Education Booklet no. 23.] *Medical Education* 1989; 23: 543 (542-558).

Stone DH. The Beer Sheva experiment and its lessons for community medicine. *Community Medicine* 1988; 10(3): 228-234.

Taylor D. *Guide for PBL tutors.* Liverpool: The University of Liverpool, Faculty of Medicine, Medical Education Unit, 1996.

Taylor D. *Personal development.* Paper at 'Transition from medical student to medical practitioner' Association for Medical Education conference 16-18.7.97 Cambridge: 14-15.

Taylor WC, Moore GT. Health promotion and disease prevention: integration into a medical school curriculum. *Medical Education* 1994; 28: 481-487.

The report of the Committee of Inquiry into the future development of the Public Health Function. *Public health in England.* London: HMSO, 1988; Cm 289.

The science of making mistakes [editorial]. *Lancet* 1995; 345: 871-872.

Thompson DG, Williams RG. Barriers to the acceptance of problem-based learning in medical schools. *Studies in Higher Education* 1985; 10(2): 199-204

Tipping J, Freeman RF, Rachlis AR. Using faculty and student perceptions of group dynamics to develop recommendations for PBL training. *Academic Medicine* 1995; 70(11): 1050-1052.

Vernon DTA, Blake RL. Does problem-based learning work? A meta-analysis of evaluative research. *Academic Medicine* 1993; 68: 550-563.

Vernon DTA. Attitudes and opinions of faculty tutors about problem-based learning. *Academic Medicine* 1995; 70(3): 216-223.

Vernon DTA. Tutor evaluation of problem-based learning in behavioural sciences courses. *Teaching & Learning in Medicine* 1994; 6: 91-95.

Wallas G. The art of thought. New York: Harcourt Brace, 1926. **Cited in:** Halpern DF. *Thought and knowledge: an introduction to critical thinking.* 3rd ed. Mahwah (New Jersey): Lawrence Erlbaum Associates, 1996: 320.

Walton HJ, Matthews MB. Essentials of problem-based learning. [Association for the Study of Medical Education Booklet no. 23.] *Medical Education* 1989; 23: 542-558.

Weil SW, McGill I. A framework for making sense of experiential learning. **In:** Weil SW, McGill I, editors. *Making sense of experiential learning: diversity in theory and practice.* Milton Keynes: The Society for Research into Higher Education & Open University Press, 1989: 3-24.

Whipple WR. Collaborative learning: recognizing it when we see it. *American Association Higher Education Bulletin* 1987; 40: 3-6.

White KL, Connelly JE. Preface. **In:** White KL, Connelly JE, editors. *The medical school's mission and the population's health: medical education in Canada, the United Kingdom, the United States, and Australia.* Proceedings of a conference by the Royal Society of Medicine Foundation, Inc., and the Josiah Macy Junior Foundation; 1990 Dec 9-12, Turnberry Isle, Florida. New York: Springer Verlag, 1992: vii-viii.

White KL, Connelly JE. The medical school's mission and the population's health. *Annals of Internal Medicine* 1991; 115(12): 968-972.

Wilkerson L, Hafler JP, Liu PA. Case study of student-directed discussion in four problem-based tutorial groups. In: Research in Medical Education: Proceedings of the Thirtieth Annual Conference. *Academic Medicine* 1991; 66: S79-S81.

Wilkerson L, Hundert EM. Becoming a problem-based tutor: increasing self-awareness through faculty development. **In:** Boud D, Feletti GI, editors. *The challenge of problem based learning.* London: Kogan Page, 1991: 159-171.

Wilkerson L, Maxwell JA. A qualitative study of initial faculty tutors in a problem-based curriculum. *Journal of Medical Education* 1988; 63: 892-899.

Wilkerson L. Faculty development. **In:** Tosteson DC, Adelstein SJ, Carver ST, editors. *New pathways to medical education: learning to learn at Harvard Medical School.* Cambridge (Massachusetts): Harvard University Press, 1994: 79-99.

Wolf A. Can competence and knowledge mix? **In:** Burke JW, editor. *Competency-based education and training.* London: Falmer Press, 1989: 39-53.

Wolf FM. Problem-based learning and meta-analysis: can we see the forest through the trees? *Academic Medicine* 1993; 68(7): 542-544.

Woods DR. *Problem-based learning: how to gain the most from PBL.* Waterdown (Ontario): Donald R Woods, 1994.

Woodward A. Public health has no place in undergraduate medical education. *Journal of Public Health Medicine* 1994; 16(4): 389-392.

Young M. A curriculum for the 21st century? Towards a new basis for overcoming academic/vocational divisions. *British Journal of Educational Studies* 1993; 41(3): 203-222.

Youngson AJ. Medical education in the later 19th century: the science take-over. *Medical Education* 1989; 23: 480-491.