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Learning from the problems of problem-based learning

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Abstract

Background: The last decade has witnessed a rapid expansion of biomedical knowledge. Despite this, fashions in medical education over the same period have shifted away from factual (didactic) teaching and towards contextual, or problem-based, learning (PBL). This paradigm shift has been justified by studies showing that PBL improves reasoning and communication while being associated with few if any detectable knowledge deficits.

Discussion: Analysis of the literature indicates that the recent rapid rise of PBL has closely paralleled the timing of the information explosion. The growing dominance of PBL could thus worsen the problems of information management in medical education via several mechanisms: first, by creating the impression that a defined spectrum of core factual knowledge suffices for clinical competence despite ongoing knowledge expansion (quality cost); second, by dissuading teachers from refining the educational utility of didactic modalities (improvement cost); and third, by reducing faculty time for developing reusable resources to impart factual knowledge more efficiently (opportunity cost).

Summary: These costs of PBL imply a need for strengthening the knowledge base of 21st-century medical graduates. New initiatives towards this end could include the development of more integrated cognitive techniques for facilitating the comprehension of complex data; the design of differentiated medical curricula for producing graduates with defined high-priority skill sets; and the encouragement of more cost-effective faculty teaching activities focused on the prototyping and testing of innovative commercializable educational tools.

Background

Many doctors have commented that their medical education began in earnest on the first day that they entered the hospital wards as a hands-on practitioner. Claims of this kind support the view that the apprenticeship model of professional learning – which has been the backbone of training in the healing arts for thousands of years [1] – remains as central to medical career development today as ever [2]. A perennial complaint of the medical apprentice-in-training is that there are too few structured teaching activities within the busy world of postgraduate work [3], a concern which many institutions have addressed by developing formalised continuing education initiatives reminiscent of medical school courses [4-6]. Predictably, different complaints prevail at the pre-licensure phase of the training spectrum, where students often feel more motivated to acquire the (implicit) competence of the practising doctor [7,8] than to absorb large volumes of (explicit) scientific and/or humanistic theory [9,10].

Such feelings underlie an unresolved debate over the optimal balance between factual ('teaching', or content-based) and practical ('training', or performance-based) components of professional development [11] and, as such, could explain a recent drift away from the didactic emphasis of older biomedical educative approaches [12] and towards quasi-experiential, or problem-based, learning [13,14] (PBL; Figure 1A). This hypothesis cannot fully account for the PBL-led transformation of medical teaching in the 1990s, however, overlooking as it does a powerful contrary trend: the explosive proliferation of biomedical knowledge [15,16] as epitomized by the completion of the Human Genome Project [17]. Although at first sight contradictory, this reciprocal relationship between knowledge growth and didactic teaching invites a unifying explanation: namely, that the switch of educational philosophy to non-didactic methods represents a strategy for teachers and students to cope with the expansile information environment [18,19].

There are many things which a fresh medical student, unburdened by factual knowledge, can begin to learn: basic surgical methods, resuscitation interventions, generic reasoning skills, and counselling techniques, to name a few. The pivotal question, then, is not whether such context-dependent (but sequence-independent) learning will prove effective [20]; rather, it is why this reorientation of teaching philosophy has occurred at all, and at this time. Or to put the issue another way: what is the hard evidence indicating that the original educational system was broken and that the new system is likely to fix it?

A secondary issue, which has been a prime concern of PBL critics [21], is whether there may prove to be long-term hidden costs payable for the clear short-term benefits afforded by the PBL teaching philosophy. Since there are major differences in the way that PBL is implemented between schools, evidence to confirm or refute such hypotheses may be impossible to assemble. By the same token, it is an oversimplification to view all PBL as having low fact-based content, just as it is to equate all older teaching methods with rote learning. Nonetheless, since PBL veers more to the active/contextual, and didactic teaching to the passive/factual, it is plausible that one bias occurs at the expense of the other.

Discussion

What is knowledge – anyone know?

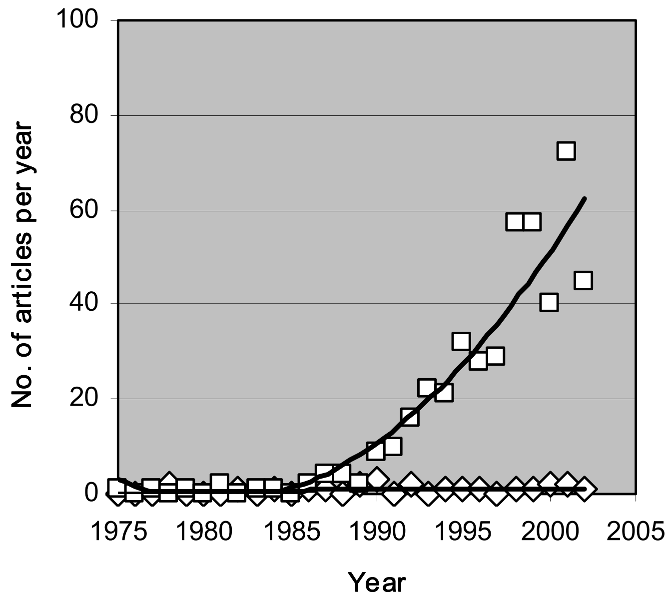
The traditional educational sequence involves theory preceding application, an accelerated model of which has long been satirized in clinical circles as "watch one, do one, teach one". As noted above, however, some applications may be learned in the absence of theoretical knowledge, just as some subsets of theoretical knowledge may be unassociated with any obvious application. Is it possible, then, to define a minimum essential "core knowledge" spectrum for the student of biomedicine? If so, should such knowledge expand in parallel with other biomedical information, or should any such expansion be restricted by its relevance to changes in clinical performance (the 'barefoot doctor' model)? In the latter case, how long can healthcare competence and credibility be maintained in the face of rising constraints on scientific core knowledge [22]?

If core knowledge is indeed expanding at a rate similar to that of non-core knowledge, then the strategy of solving the broad problem of knowledge expansion by defining a narrower core can only be a temporizing measure. On the other hand, if the quantum of core knowledge is deemed non-expansile – arbitrarily defined, for example, to represent the amount of knowledge capable of being instilled in an average student by x teaching hours per week spread over y years – then any expansion of non-core knowledge will cause the core to shrink as a proportion of total knowledge. In 1984, for example, a list of two hundred drugs was hailed as a solution to information overload in the field of pharmacology [23]; but by 2000 the overload problem in this discipline was perceived to have deteriorated despite both the embracement of PBL and relentless efforts to re-define a core curriculum [24].

A key difficulty in addressing this problem is that expansion of biomedical information is asymmetric – different areas of knowledge grow at different rates which in turn vary (and are ascribed differing priorities) during different periods (Fig. 1B). In practice, most curricula cope with differential knowledge growth by adding new core modules to cover areas of rapid growth [25]; the problem with this approach is that the notion of "core" becomes fluid, invalidating the concept. Moreover, it is difficult to discard ageing core knowledge at the same rate as adding new information, since the credibility of newer information tends by its nature to be weaker than that of older content. Rigid conservation of the core leaves trainees selectively deficient in new knowledge areas, on the other hand, making them less competitive in the marketplace. Discrepancies emerging between planned (taught) and actual (learned) medical curricula [26] further weaken the practicability of paradigms based on core knowledge.

The concept of core knowledge as a stand-alone solution to the problem of information inflation thus appears flawed [27]. Although at any one time certain knowledge subsets may be deemed dispensable for learning purposes, a continuous expansion of knowledge must imply a comparable expansion of knowledge essential for

A



B

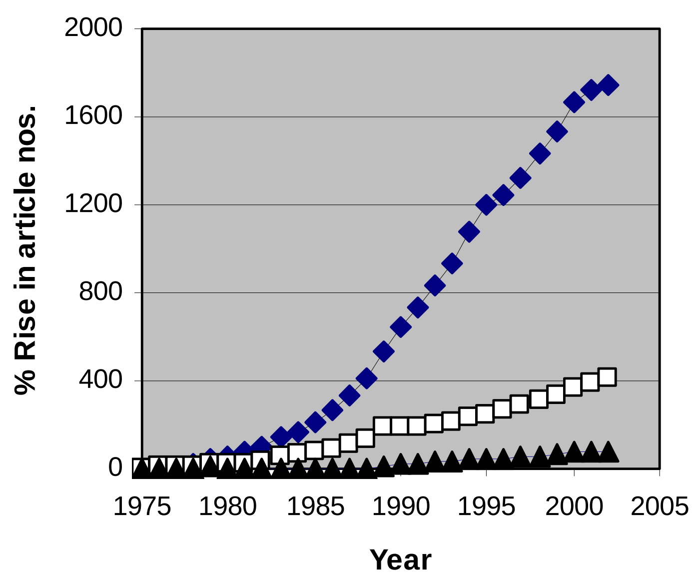


Figure 1
Comparison of growth rates of PBL and biomedical knowledge. (A), Relative growth of interest in PBL versus lecture-based teaching based on PubMed keyword frequencies between 1975 and 2000. The Title fields of the journal database were searched each year for the strings "problem-based learning" (open squares) or "lecture" (open diamonds); the retrieved items were then scrutinized to determine those dealing with the subject of teaching style (e.g., eponymous "lectures" were excluded). (B), Growth rates of journal articles dealing with subject matter relating to science, medicine and education. The strings "gene" (solid diamonds), "clinical" (open squares) and "medical education" (solid triangles) are shown here, illustrative of the frequencies of many other keywords searched.

maintenance of professional competence [28]. Moreover, practicality should not be the sole criterion by which core knowledge is judged; a medical training system cannot succeed by simply cloning service-based doctors, but must also produce academics, researchers, visionaries and leaders able to develop the service infrastructure [29]. It is against the background of these diverse challenges that the recent growth of PBL should be appraised.

The lure of the non-expert

A traditional authoritative doctor who dares challenge the information explosion faces the same risk as the immovable object confronting the irresistible force. The outcome has been to shatter the image of the omniscient doctor, as well as to dent the plausibility of experts in all fields. This slide from grace of the specialist – formerly a dominant figure in the medical educational pantheon, and a revered colleague in the battle against information overload [30] – has paralleled the decline of the lecture as a teaching medium. These linked trends suggest that the internet-empowered medical customer of the 21st century (whether patient or student) now questions information promulgated by mere individuals, thus threatening clinical and teaching paradigms formerly assumed unassailable.

This problem has created a niche for PBL, rejecting as it has the old curriculum's reliance upon experts and specialists [31]. The reported disadvantages of non-expert biomedical teaching with respect to knowledge transmission [32] and disease understanding [33] have been parried by numerous studies showing no detectable information deficits in PBL-trained (compared to lecture-taught) students [34-38]. Such negative data may be of limited reassurance, however, given the insensitivity of the endpoints used to measure what is in practice a rather limited curricular divergence [39]. It is likewise arguable that endpoints such as knowledge acquisition and clinical skills are surrogates, and that the most critical deliverable of medical training – namely, the quality of patient outcomes – has not been measured in any controlled trial of PBL [40]. These points lend credence to criticisms that the present-day popularity of PBL has so far been driven more by individual enthusiasm and conjecture than by objective scientific evidence [41].

Who, then, stands to gain from PBL? Medical teachers are perhaps the most immediate beneficiaries [42]. Reduced self-perceptions of fallibility may be one attraction for teachers, as new PBL supervisors find that their educational contributions are no longer falsifiable by their pupils. In addition, responsibility for providing a sufficient knowledge base can be passed from teacher to student under the PBL auspices of 'self-directed learning' [43]. Yet another benefit relates to the lack of formal preparation required to initiate a PBL session [44] – an advantage which suggests a gain in efficiency. But does this bear scrutiny [45]?

Things have changed

Efficiency can be calculated by dividing (productivity) by (time and effort). What do we mean in this context by productivity? A half-century ago, the only responsibility of a medical school was to produce clinicians to serve the local community; today, however, teaching activities incorporate postgraduate specialist education, continuing medical education, professional and career development, public and patient awareness programmes, education-related research, conference and workshop organization, national and international collaborative initiatives, professional accreditation and audit activities, development of electronic teaching resources, and so on. Hence, a modern faculty's teaching productivity is not able to be gauged exclusively (or even predominantly) by the number and quality of its outgoing medical graduates, but rather must be judged by the sum total of its useful educational output.

This raises short- and long-term issues as to the most efficient ways to utilize faculty time and effort: traditional teaching service activities (e.g., tutorials, mentoring) must compete with more ambitious developmental activities (e.g., production of journal articles, books, software or web resources). Small-group tutorials are a time-honoured teaching modality, but the opportunity cost is high; while there must surely remain a place for personalized teaching, it seems doubtful whether the modern academic system can tolerate the luxury of an accelerating trend in this direction [46]. In contrast, the traditional apprenticeship training approach seems cost-effective, relying as it does upon the learner assisting a professional in the execution of his/her paid duties.

In this context it is worth noting that the development of PBL – growth of which during the 1990s coincided with similar trends favouring noncognitive-based medical school admissions [47-49] and humanities-rich preclinical experience [50-52] – was spawned a quarter of a century ago in a regional medical school in Canada [53]. One need scarcely point out that the 1975 academic environment responsible for this educational breakthrough bears little resemblance to the market-driven imperatives that preoccupy most medical faculty members today, both in Canada [54-56] and elsewhere [57-62]. A changing environment not only justifies, but mandates, adaptation; if the 1990s trends do indeed represent a retreat from an information-dominated world, then the substitution of a PBL-dominated philosophy could be fraught with significant longterm perils.

From words to actions

Solutions lie in compromise. Such change is painful because it involves the abandonment of ideals formerly attainable; the vision of a one-size-fits-all medical school becomes no longer practical, and ever more difficult decisions will be needed as to what style(s) of graduate is most urgent for a faculty to produce. This process of curricular differentiation has started, but the pace is set to quicken as medical markets emerge and diverge, and as competition for faculty survival sharpens. To what extent, though, should these divisive educational decisions be made by markets, faculties, students, patients or governments?

Contrary to popular thought, there will remain a strong need – and possibly an enlarging one – for a subset of highly-trained medical graduates from a knowledge-intensive learning environment who are capable of assimilating the complexities of science, informatics, humanities and logistics that comprise modern medicine. Since the proportion of individuals and faculties suitable for this leadership mission looks set to decline, however, a larger number will need to accept the equally daunting compromise of skills prioritization.

Teachers cannot teach without students, but students can learn without teachers. This belated insight has transformed the role of teachers into that of learning facilitators, akin to a culture of "thinking apprenticeship". Paradoxically, in an age when even complex skills such as landing aircraft are learned using robotic simulators, the trend in medical education has switched back to labor-intensive small-group teaching under the guise of PBL. This at first seems all the more curious given the unprecedented availability of alternative technologies for teaching clinical reasoning, the increasing importance of an adequate knowledge base in an ever more sophisticated professional environment, the growing pressures on faculties to use limited fiscal resources in the most cost-effective manner, and the novel opportunities for commercializing educational activities and products via the development of software and web-based resources.

The rise in PBL popularity over the 1990s thus suggests a retreat from the fallout of the biomedical information explosion. Although this response seems rational enough as a short-term adaptive measure, it should not be regarded as a solution to the problem of knowledge expansion. Just as PBL was originally pioneered as a reaction against complacency in traditional pedagogy, so must today's medical schools reject expediency and confront the unresolved information-management challenges of 21st-century medical education. The formulation of more efficient techniques for imparting factual knowledge, a greater emphasis on directing limited resources to the production of reusable teaching tools [63], and a willingness to experiment with differentiated medical curricula that prioritise graduate skill subsets, can all play a role in driving educational reform as a positive and ongoing adaptive process.

Summary

The knowledge explosion of the last two decades has been accompanied by a decreasing reliance on didactic teaching. This educational paradigm shift has been led by widespread embracement of PBL, the original rationale of which was to improve students' ability to reason and communicate. In recent years, however, PBL has grown more rapidly in apparent response to information overload in medical school curricula, and may thus be viewed as a symptom of the problem of biomedical knowledge expansion.

The challenge of defining the right balance between what is taught, what is learned, and what remains unlearned will not disappear. Although few knowledge deficits have been detected in today's PBL-educated students, a decreasing concern with the adequacy of the professional knowledge base could yet erode the future credibility of the medical profession. By continuing to rely on popular PBL escape clauses such as 'self-directed learning' and 'information management', today's medical educators risk losing sight of this longterm threat.

The era of active learning began thousands of years ago with the first apprentice. We now live in a new era with new challenges, one of which is exponential information expansion. PBL provides one way for faculty and students to cope with this challenge, but sidesteps deeper issues relating to the widening core of essential professional knowledge. Innovative curricular experiments using educational strategies complementary to PBL would therefore appear timely.

Abbreviations

PBL, problem-based learning

Competing interests

None declared.

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