Problem-Based Learning – Is it Relevant to Clinical Education?

H. T. Aretz

Ist Problemorientiertes Lernen relevant für die klinische Ausbildung?

Abstract

Problem-based learning is both a teaching method and a philosophy that supports the goals and desired outcomes of medical education. Its role in clinical education of medical students is evolving and remains a matter of debate. This article examines its role in light of two models: the continuum of professional development and the iterative problem-solving loop. The important conclusion would be that medical students change during the course of their studies, and that teaching methods and learning experiences cannot remain static over the course of four to six years.

Key words
Problem-based learning · clinical education · teaching methods · professional development

„Many advantages over the didactic lecture and the recitation system were claimed for the case method, but the peculiar merits claimed for it were the arousal of student enthusiasm and interest, the easy possibility of correlating the scientific and clinical sides of medicine, and the drilling of the mind in judging data. Not only have these claims been verified, but new merits, unforeseen, have presented them-selves."
W. B. Cannon, Student, Harvard Medical School. Boston Med Surg J. 1900; Vol 142

Introduction

The above quote from Walter B. Cannon when he was a medical student at Harvard Medical School is still one of the best and most concise descriptions of the case method and its effects I know. Clearly, the case method is not synonymous with problem-based learning (PBL) in its strict sense (see below) and in many ways the definition of what is meant by PBL has done much to confuse the issue and to divide the camps, despite some attempts at clarifying the issue [1]. Regardless of one's definition of PBL, the quote above eloquently summarizes and emphasizes the power of using cases – real, virtual or paper – in providing linkages between theory and practice, while achieving many other objectives often mentioned in discussions of PBL [2]. Barrows listed as the main goals of PBL [3] as the structuring of knowledge for use in clinical contexts, the development of an effective clinical reasoning process, the development of effective self-directed learning skills and increasing motivation for learning. The connection to clinical reasoning, which is also one of Walter B. Cannon's „verified merits", however, is quite difficult to prove from the existing literature.

When I was asked by the editor of this issue to write a general article on PBL in clinical education, I searched the literature on the subject and quickly had to agree with Foley and colleagues [4] that there was not much written in the literature, and even less if one critically examined the substance of the articles, which at first glance appeared to be dealing with the subject. Since the publication of their review in 1997, the subject has not been reviewed again, and there are only scattered reports about the use of PBL in the clinical years. Only a minor portion of the PBL literature concerns itself with clinical education; most publications address the use of PBL in the teaching of basic sciences

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to enhance their clinical relevance and their correlation with clinical scenarios.

In the discussion below, therefore, I will step back and try to give an overview of the following topics:

- The general process of curriculum planning and the role of PBL in that process.
- The relationship of PBL sessions to other teaching methods and learning experiences in a given course.
- Other non-traditional approaches in the clinical environment.
- PBL and its variations as different expressions in a continuum.

As an editorial note, I would like to add that this article represents very much a personal opinion formed over the last eight to ten years, while I had the pleasure of working with colleagues around the world on medical education and curricular issues. My contacts with other professionals involved in health care (e.g. consultants, business men, allied health educators) have been invaluable in this process.

Curriculum planning and PBL

In the last 20 years and more, medical curricula around the world have been changing, and PBL has been a part of almost all of them. The drivers of this change have included:

1. *Factors related to medicine per se*: changes in the demographics of populations; the epidemiology of disease and change in burden of disease; economic factors; the rise of the quality movement and attention to medical errors; the ever increasing knowledge base underlying the science and practice of medicine; the changes in delivery of care including multidisciplinary teams, integrated delivery networks and population-based approaches; and societal expectations of health professionals [5].
2. *Factors related to the understanding of teaching and learning*, such as adult learning (Androgogy – see Table **1**) [6].
3. *Factors related to the shift to outcomes-based medical education concentrating on competencies and performance* [7].
4. *Factors related to shifting the emphasis from teacher direction to facilitation of the learner.*

PBL has been felt to address many of the above issues, especially those of integration, application of adult learning theory, acquisition of professional competencies (e.g. life-long learning skills, team work) and increased student independence and motivation. It may, however, be useful to reemphasize that PBL is both a method and underlying philosophy and it is used to achieve a goal, and not necessarily a goal in of itself. As my colleague Elizabeth Armstrong [8] points out, what is taught and how it is taught needs to be informed by sound pedagogy, seen in context of the specific situation and stage of educational development, as a function of the goals and desired outcomes, and constantly modified by evaluation (see Fig. **1**). If used appropriately, PBL can address many of the aspects of the four factors outlined in the introduction above:

The appropriate and judicious use of a variety of PBL scenarios (e.g. paper-based cases, data, pictures, videos, publications, real or standardized patients, simulations) can address the rapidly changing face of medicine in a flexible and realistic fashion, thereby addressing many of the medicine related factors outlined above, especially integration. Its success does depend however, on the selection of the scenarios in such a way that they address the needs of the learners at their various stages of development.

Table **1** The principles and assumption about adult learning (Androgogy)

Adults are independent and self-directing
Adults have a good deal of experience, which is a rich resource for learning
Adults value learning that integrates with the needs of their everyday life
Adults are more interested in practical problem-centered approaches than subject-centered approaches
Adults are motivated by internal rather than external drivers

Adapted from reference [6]

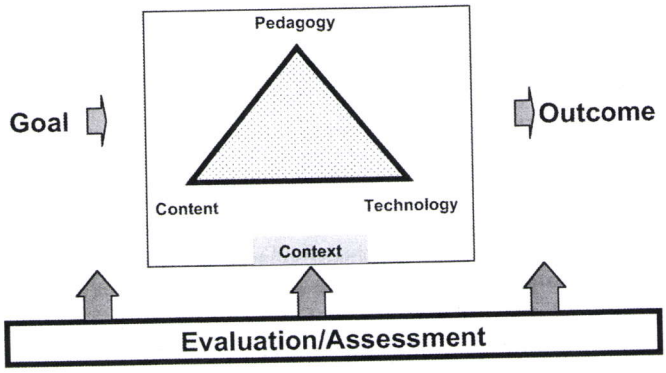

Fig. **1** The goals need to determine pedagogy, content and educational technology, while understanding the context in which the learning takes place. This in turn needs to lead to the desired outcomes, and the entire process needs to be informed at all stages and times by evaluation and assessment.

In comparison to traditional didactic teaching and passive learning environments, PBL can better address the various aspects of adult learning. Used well, PBL can recognize the learner as being independent and encourage self-sufficiency and direction; PBL builds on prior knowledge by the learner; PBL-type materials and exercises should relate to relevant experiences by the learner and create a linkage to his or her daily responsibilities and future needs; PBL can by using the right scenarios create meaningful learning arising from real problems rather from proscriptive didactic sessions; and PBL can provide the learner with internal drivers through curiosity, a feeling of relevance and equal social standing. Although these goals have been quite ably accomplished in the preclinical setting, several authors [9–12] have pointed out the possible shortcomings of traditional PBL in the clinical years or its relevance to clinical decision making.

PBL and its relationship with other teaching methods

Very few medical schools and medical faculties, which have adopted PBL as the preferred teaching method use it as the exclusive method. Ross [13] actually divided medical curricula using

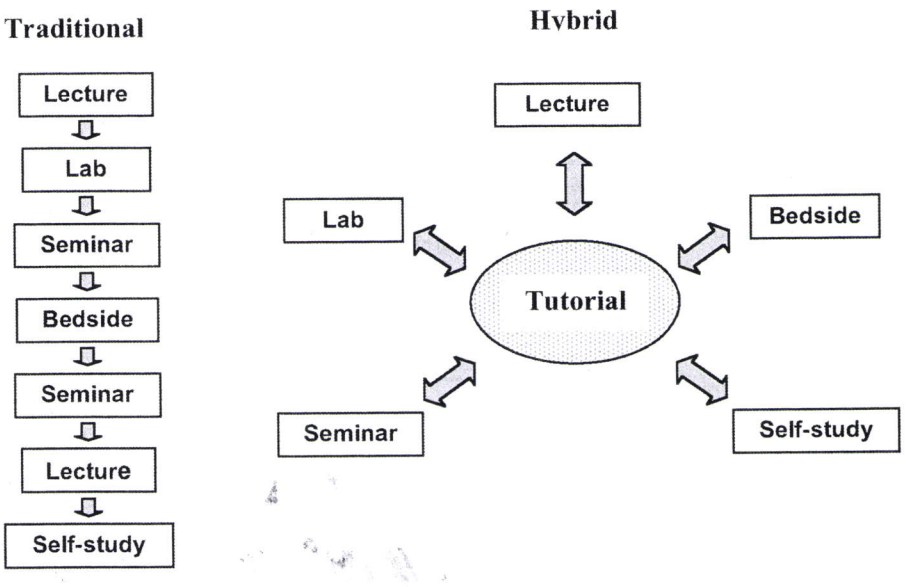

Fig. **2** In hybrid curricula, tutorials often play the role of integration of a variety of other teaching and learning experiences, whereas in a traditional curriculum these experiences are often arranged in a linear fashion without a „formal" mechanism for integration.

problems into problem-based curricula, problem-oriented curricula and problem-solving curricula. The majority of medical schools use a hybrid model [14] of teaching and learning strategies. As has been recently outlined, PBL sits side by side in most curricula with more traditional teaching methods such as lectures, practicals, exercises, clinical skills sessions and sessions teaching communication skills [15]. Fig. **2**, developed by my colleague Karl Matlin [16] illustrates the difference between a traditional and a PBL-hybrid curriculum, emphasizing the central integrating role of the PBL sessions. It is this role that has been difficult to accomplish in the clinical curriculum, partially based on the major differences in the curricular structure of the clinical years in the various medical educational systems.

In the German medical curriculum and in other countries that follow its general outline, the first two clinical years (years 4 and 5 of the German curriculum) have traditionally been mostly theoretical with some bedside and practical clinical teaching, supplemented by practical experiences, such as the Famulatur. In this context, some schools introduced PBL courses or exercises, either as the result of student initiatives on an initial voluntary basis [17] or as part of the „official" curriculum [18–20]. The recent law (Approbationsordnung) is forcing similar changes to the clinical years in general. The intent and structure of some of these efforts differed; some used real cases as the basis for discussion, while other schools continue to use paper cases to support the integrative function of PBL. Common symptoms („Leitsymptome") and clinical scenarios are used to help integrate different clinical specialties, while at the same time reinforcing the need for integration not only on a scientific basis, but also on a professional basis. In this way, these PBL sessions help with the vertical integration of basic science and clinical practice, and the horizontal integration of the various specialties centered around clinical scenarios and symptoms.

In the UK model of medical education, traditional PBL has been acknowledged as being useful in the preclinical setting and in the first one or two years of the clinical education (phase 2). In the last year or two (phase 3), however, when the students spend time almost exclusively in the clinics as part of clinical teams, this has proven to be difficult, or the role of PBL was found to be altered in this setting. Harden [12] felt that it was difficult to create truly integrated clinical teams supportive of a more traditional PBL-type setting during the rotating clinical attachments in year 4 at the University of Dundee, and the idea was abandoned in favor of the task-based approach in the final clinical years. Paul O'Neill [21] at the University of Manchester, recently commented on the shift in the role of PBL in years 3 and 4, leading to a linkage of PBL with clinical experience through something he calls „elaboration". The two experiences become complementary and cross-fertilization occurs between the two modalities. In the final year 5 in Manchester, the method is further refined [22] and students bring their own cases to the discussions, shifting from disease mechanisms to diagnosis and clinical management, with tutors now acting as expert resources and allowing for flexibility of the format beyond the one suggested by the university in the previous years.

In the North American model, students traditionally move into the clinics and hospitals on a full time basis in their third and fourth years, the two clinical years in this curriculum model. PBL is rarely found in this context, and didactic group discussions take place as part of the daily work or in more formal teaching rounds, either solely directed at medical students or at medical students and house staff together. The subject of the discussions is invariably a real patient under the care of the team in the hospital or in the outpatient setting. Most of these discussions do not follow the traditional PBL format and vary widely, but in general are much more Socratic in their approach than is the case in the traditional PBL setting [23]. Although disease mechanisms still form part of the discussion, the emphasis shifts to diagnostics, differential diagnosis and management. At Harvard, students still return one afternoon a week during their third year to the medical school for PBL sessions as part of the patient-doctor sequence (patient-doctor 3 course [24]). Real patients are discussed to elaborate concepts in ethics, professionalism, patient safety and other „non-scientific or clinical" aspects of patient care. Such separate PBL exercises have not found to be useful for the more clinical aspects of patient care, as they feel artificial to the participants, once they are immersed in clinical practice on a

day-by-day basis. As part of the patient-doctor sequence, these exercises are useful however, as they enhance and foster reflection among students, while providing a safe forum for sharing some of their personal reactions to the clinical environment. In general, traditional PBL is not used once the students move into the clinical environment on a more full-time basis (i.e. year 6 in the German system, year 5 (and 4 in some instances) in the UK system, and years 3 and 4 in the North American system).

Other non-traditional approaches in the clinical environment

As I alluded to above, there have been multiple approaches to modifying or supplanting PBL during the clinical years and before based on several considerations:

It may be difficult to implement from a logistical point of view once students enter the hospitals and clinics [12]. This led to the development of the Task-Based Learning (TBL) approach.

When it is used in the clinical years, PBL evolves and the traditional format is modified as the students' clinical experiences inform and supplant the theoretical context of PBL [21,22].

New approaches have been introduced in the preclinical years to more closely mimic „real clinical decision making" [25].

1. One of the hallmarks of PBL is its ability to be the focal point for integration in multidisciplinary courses, leading to a better understanding of overarching concepts and basic underlying principles. Although the use of integrated courses in preclinical and early clinical medical education has increased virtually everywhere in the world, it is still quite difficult to teach practical clinical medicine in a truly integrated structure. Despite the recent creation of multidisciplinary clinical product lines (e.g. women's health, cancer, geriatrics, cardiovascular health, stroke centers), the delivery of medical care still takes place along traditional departmental lines. In this context, the TBL model [12] at the University of Dundee has placed the responsibility for integration squarely back on the shoulders of its students. It has developed a set of 113 tasks, organized in 16 groups accomplished throughout the 10 clinical rotations (attachments), assessed by portfolios, written assessments and OSCEs. Study guides support the students' learning and provide the necessary framework for integration. According to the authors, TBL emphasizes outcomes rather than processes and thereby provides an appropriate approach to medical education in the latter years. It is interesting to note in this context that basic science departments in the USA have undergone significant reorganization over the last 20 to 25 years. The increasing number of interdisciplinary research teams, the changes in PhD training programs and the funding environment all have contributed to this trend. Mallon and colleagues [26] conclude that „basic scientists are becoming increasingly dissociated from the traditional disciplines around which medical students are educated". It is intriguing to speculate whether a similar trend will take place in the reorganization of clinical care. As has been observed about education in general [27], education has been traditionally the „recipient of the dominant social pressure for change, rather than being a major force for change in itself".
2. Over the course of four to six years in medical education, students mature or at least change in their knowledge base and skills, making it rather plausible that their approach to PBL-type cases will change as well, as has been pointed out by several authors [21,22,28]. Most medical curricula are structured along the step-wise acquisition of knowledge and skills: from understanding the relevant basic and social sciences; to understanding normal structure and function and its ascertainment by diagnostic and historical means; to the understanding of abnormal structure and function and its diagnosis; to clinical diagnosis and management, based on current accepted knowledge and appropriate diagnostic tests and delivery of care. It should not be surprising then that in many of the hybrid curricula, PBL is used to teach the underlying concepts of each of these steps and provide vertical and horizontal links. The emphasis in the subject matter will logically vary at these various stages in the curriculum, but the basic principles of PBL still force the learner to step back, reflect and revisit the understanding of concepts in light of recent discoveries and the practical situation. Recent studies have shown that this aspect is underdeveloped especially in clinical curricula [29] and that students in many disciplines graduate with the same misconceptions that they started with [30].
   This step-wise, case-based approach to medical student learning and teaching is a time honored one (see Cannon's quote) and forms the early basis for experience and therefore expertise (see below). Although there is still discussion as to whether PBL can be used successfully in the basic sciences [31], there is general agreement that preclinical teaching using this method provides for a more meaningful medical context [32,33]. In addition to the shift in subject emphasis, there is a shift in the expected outcomes from the group process. David Garvin [34] has emphasized that in order for learning to be useful, its application is a necessary step after its acquisition and evaluation. At each of these stages, however, natural biases occur and hamper effectual learning. The ability to create practical and applicable solutions that stand up to practical clinical scrutiny becomes increasingly important as medical education moves into the clinical realm, and it is here that PBL is often criticized as being too theoretical and subject to the „wrong kind of reasoning".
3. In response to this latter criticism, there have been attempts to either explicitly teach medical decision making as a separate effort [35,36] or to provide an organized approach utilizing schemes developed by experts [25]. The former approach claims greater time efficiency when compared to PBL. The latter approach was developed as part of a clinical presentation curriculum at the University of Calgary Medical School in Alberta, and has been touted as a superior approach to curriculum design [10]. In teaching medicine in the context of 120 clinical presentations, schema developed by experts were introduced „to serve as frameworks around which students could learn new information" and „to provide an approach to clinical problem solving". This approach was felt to more closely resemble the „forward thinking" (from data to diagnosis) approach of experts rather than the „backwards thinking" (from possible diagnosis to data) approach using the general PBL method (see below). Initial results indicated that the schemes were useful to the students, but that their usefulness tapered off after a certain time [25]. In addition, it was not sur-

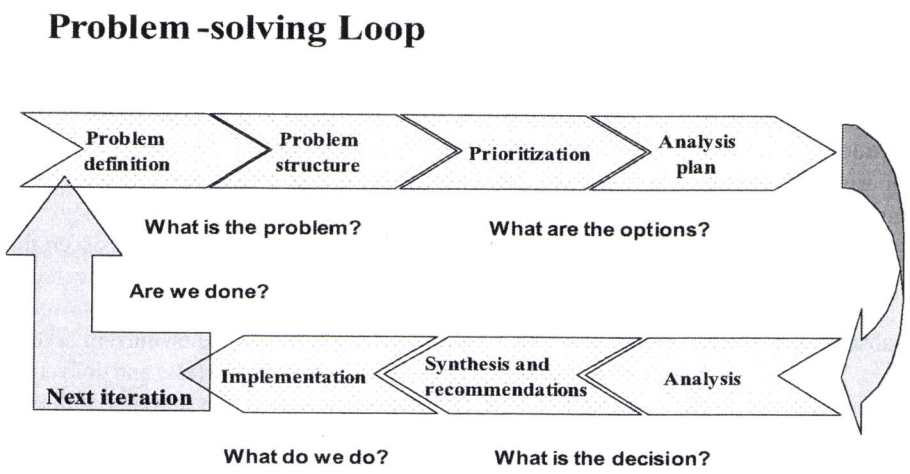

Fig. **3** The above problem-solving loop provides a more „generic" approach to problem solving and is helpful when tackling new unfamiliar and especially complex problems.

prising that some faculty members rejected the schemes, as is the case with predetermined guidelines in general [37]. No data are yet available about the effects of this teaching methodology in the clinical years.

PBL and its variations as different expressions in a continuum

I would like to argue that many of the issues raised above and the solutions proposed are all part of a spectrum and emphasize different stages of the problem-solving loop (Fig. **3**), derived from and modified during my work with professionals in other disciplines. Interestingly, Barrows [3] listed a „closed loop or reiterative problem-based" method at the top of his taxonomy of problem-based methods (with lecture-based cases, case-based lectures, case method, modified case-based method and problem-based as the others in ascending order). Although it may resemble superficially the popularized seven-step process of PBL [15], it is somewhat different. In brief, when we attempt to solve problems, we need to understand what the problem is, create a set of ordered options, decide what to do based on evidence, do it, and revisit what we have done to evaluate the process and determine the next steps.

The difference in some of the above mentioned approaches to clinical problem solving from the PBL method and particularly its philosophy relates in my opinion partially to the following two issues:

Medical professionals at various stages of their development structure problems differently.

The expected outcome of the educational interventions varies in different curricula, exercises and stages of medical student education.

I would like to refer to the Dreyfus development model [38,39] as a background to address the first point. In a recent publication [40] the first five steps of development from novice to expert as applied to medical education were summarized and are shown in Table **2**.

Table **2** First five steps of the Dreyfus development model

Dreyfus Stage	*Stage of medical education*	*Learnings applicable to medicine*
Novice	Beginning medical student	Learning the processes to allow data gathering and provide the foundation of knowledge and skills (e.g. history taking)
Advanced beginner	Medical student in clinical years	Recognizing common aspects of patient situations in a concrete setting which can only be learned by experience; beginning to create maxims based on the experience
Competent	House staff	The learner applies the knowledge and skills to individual patients under supervision, with evaluation of the consequences
Proficient	Specialist early in career	Development of routines that allow for streamlining of patient management
Expert	Mid-career physician	Uses „patterns and intuition" to guide clinical practice and recognizes patters that „do not fit"

Modified and adapted from reference [40]

In this schema, medical students are classified as advanced beginners, a fact not necessarily always acknowledged by residency training programs, which often expect a much higher level of expertise. If one accepts that level as being appropriate however, one recognizes that the desired result of medical school education is a graduate who possesses the necessary tools to gather appropriate data, interpret them in the context of a concrete experience – a patient – and has learned to abstract from that experience, thereby being guided in his or her future learning. This is a far cry from the expert able to recognize patterns and translate them into actions immediately.

In the development of expertise, professionals are increasingly able to create more sophisticated ways of problem structuring and thereby create „shortcuts" in the problem-solving loop, i.e. recognize the problem and its elements and gather just the right data allowing them to move to synthesis and implementation more readily (Fig. **4**). As implementation and action are becoming more important, skills that allow for this shortcut to occur

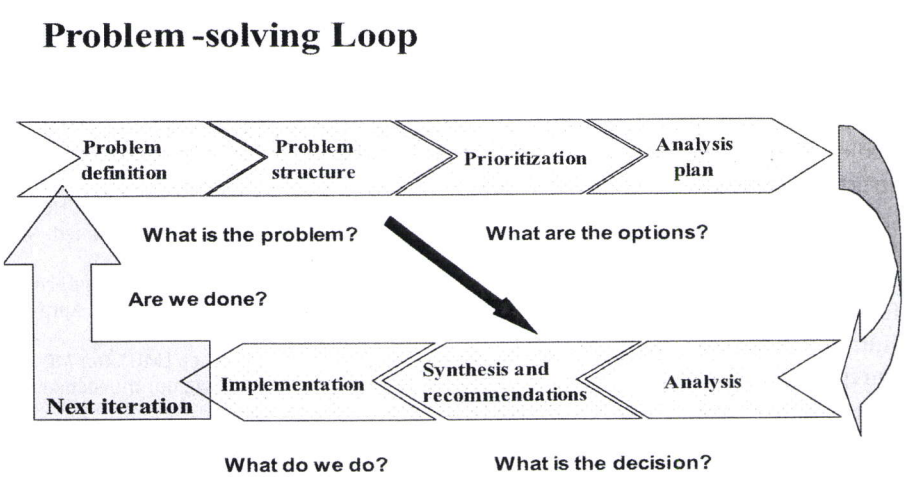

Fig. **4** The black arrow attempts to illustrate a possible „shortcut" to problem-solving as it might be the case with an expert solving a familiar problem. Based on experience, the expert is able to immediately structure the problem and understand the important options and can thereby, with the help of some selected data, readily synthesize the issues and suggest a course of action.

become more desirable, but are a function of increasing experience and the ability to apply mixed reasoning strategies as required by the task. The ability to use analogies (based on a deeper understanding of the problem) and specialization of general routines (creating shortcuts) are two characteristics of experts [41]. When confronted with unfamiliar problems and complex situations experts often resort to backward reasoning (PBL-type reasoning) [42].

Problem structuring can occur in several ways, such as deductive (backwards), data-to-hypothesis driven (forwards) and issue map (pattern) driven, listed roughly in the order of expertise and familiarity with the issue. As mentioned before, it is the deductive pathway that felt to underlie PBL and it is this fact that has led to criticism of its applicability to clinical reasoning.

To illustrate the point, think of how one might approach determining the cause of death of a man. In a purely deductive reasoning strategy, one might ask the questions: What are all the possible ways this person could have died? He could have died from natural causes, committed suicide, been murdered or died in an accident. As a next step, one would think of all the possible ways one could commit suicide or be murdered, etc. This process very much mimics the brainstorming aspects of PBL in the early stages of medical education and it has its definite usefulness in probing the understanding of concepts and in solving unfamiliar and complex issues. The learner stays mainly in the structuring and analysis part of the loop and only secondarily thinks about implementation. If we actually understood all aspects of normal function, we should be able to postulate all possible mutations of abnormalities. Black holes for instance were postulated based on relativity theory before they were ever discovered, and similarly, the existence of certain cardiac malformations was proposed based on the understanding of cardiac embryology, prior to their clinical identification, i.e. theory predicted data.

In the data-to-hypothesis driven framework, one might approach the problem of the dead man by postulating that he died of natural causes based on the fact that there were no suspicious circumstances and that other findings pointed to a cardiac death. This presupposes a much greater knowledge base and the ability to recognize a constellation of data, signs and symptoms as pointing to that hypothesis. One still needs to confirm this initial impression, but it allows for a rational approach to the search of new data and to treatment, i.e. implementation and action. There are some dangers in this approach: one is the selective acceptance or rejection of data, i.e. a bias towards those data that support the hypothesis, and another might be the inappropriate attribution of cause and effect [34].

Finally, one needs to be reminded that expert knowledge and skills are domain and subject specific and often not transferable to other situations, whereas the application of the iterative problem-solving loop allows for an organized and logical approach to new domains of learning. This is most evident in the area of motor skills. As most of us can attest to, proficiency or expertise in one sport does not translate into immediate expertise in another sport, even if both involve hitting a ball with an instrument (i.e. tennis and golf). In addition, expert athletes spend enormous amounts of time analyzing their craft and hiring people that will help analyze them, recognizing quite well that experience without feedback will reinforce bad habits as frequently – or maybe more often – as good ones. I realize that the examples from sports may not be appear to be directly applicable to medical decision making and that they are quite simplistic, but the Dreyfus model was developed for many activities including learning a second language, driving or playing chess [8–40]. A recent business publication [42] drew a different comparison, namely between experienced bird watchers and expert internists. Both parties were able to recognize complex patterns in the course of seconds or minutes, faster than one could explain by rapid problem solving, but clearly neither expertise transferred to the other domain.

Summary

As mentioned in the beginning, PBL is both a teaching method and philosophy that supports the goals and desired outcomes of medical education. Its role in clinical education of medical students however is evolving and remains a matter of debate, partially because of a misunderstanding of its intent. I have found it useful to examine its role – and the role of any teaching and learning strategy – in light of the two models I presented: the continuum of professional development (the Dreyfus model) and the iterative problem-solving loop (as used by consultants

and also proposed by Barrows [3]). It is important to remember that medical students change and evolve during the course of their studies, and that teaching methods and learning experiences cannot remain static over the course of four to six years. It may therefore be quite appropriate to start medical students by concentrating on problem recognition and structuring and acquiring increasing sophistication in this task, before moving on or possibly force-feeding them approaches to problem-solving aimed at practical implementation, which may be beyond their level of development or prevent them from fully understanding the deeper concepts. Certain aspects that are intrinsically linked to and are an integral part of PBL deserve to survive throughout our professional lives even if the method changes over time: The ability

- to approach a problem in an integrative and structured fashion;
- to gain knowledge and understanding by doing so in an independent manner;
- to look for new and relevant solutions; and
- to create a collaborative and motivating environment that invites and demands regular meaningful feedback from our peers and co-workers while sharpening our ability to judge ourselves.

If we neglect the first three, our intellectual lives will become stale, and if we neglect the last one, the cynical definition of an expert as being someone who „is often wrong, but never in doubt", may become all too true.

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