

Problem-Based Learning at the Faculty of Medicine of the Université de Montréal: A Situated Cognition Perspective

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Abstract

Purpose: This study describes the typical case of problem-based learning (PBL) application at the Faculty of Medicine of the Université de Montréal and its analysis from the perspective of situated cognition.

Method: I used a typical case study to determine the general model of PBL application and performed my analysis by a global processing of information, against to the conceptual model of situated cognition.

Results: A typical PBL tutorial case consists of a meeting of a group of about 8 students with a tutor to discuss a medical problem. Learning objectives are predetermined by faculty and recorded in the tutor's handbook. Broadly speaking, the analysis revealed a certain kind of scaffolding within a "zone of proximal development" (ZPD).

Conclusion: The adaptation of PBL at the Faculty of Medicine of the University of Montreal is hybrid, original, and can be related to the model of cognitive apprenticeship, but the tutor's role, however, does not fit the model of cognitive apprenticeship completely.

Keywords: Problem-based learning, medicine, situated learning, scaffolding, zone of proximal development.

Problem based learning (PBL) in its contemporary form started at the Faculty of Medicine of McMaster University in Ontario, Canada, at the end of 1960. Based on the gaps of traditional medical teaching (teacher-centred, parcelled out in disciplines), the founding fathers of PBL (Evans, Anderson, Mustard, Walsh, Kraemer, joined by Barrows) proposed a curriculum centred on students and on a series of biomedical problems^{1, 2} The founders of the PBL curriculum defined it as "the learning that results from the process of working towards the understanding or the resolution of a problem. The problem is encountered first in the learning process."³

Reluctantly received at first for its experiential nature without valid scientific basis,⁴ this approach went on to be adopted by a growing number of faculties of medicine throughout the world and by varied disciplines of professional and general teaching,⁵ as testified by more than 10000 scientific publications.⁶ However, this dispersion occurred with multiple adaptations outlined by Charlin, Mann and Hansen⁷, but somewhat foreshadowed by Barrows in his taxonomy of PBL.⁸

At the faculty of medicine of the Université de Montréal, the new curriculum based on PBL was introduced in 1993⁹ after a pilot project in 1991.¹⁰ Although there is

an institutional policy supporting PBL, the work of Tipping, Freeman & Rachlis¹¹ showed there is a difference between what is perceived and what really occurs during tutorials.

My work for my master's degree in education was a reflective study of the teaching approach used in the two first years at the faculty of medicine of the Université de Montréal. I wanted to know what the practical application of PBL was and how I could understand it using the lens of situated cognition.

I'll begin this text with a brief theoretical overview of various theories used to explain PBL and a deeper discussion of situated cognition, followed by the study's context, methods, results and discussion.

Learning theories related to PBL - Cognitivism, constructivism and their derived theories have been used to explain the theoretical bases of this approach.^{12, 13, 14, 15, 16} What are the common features and differences between them?

The common point is that all these theories come from developmental and cognitive psychology, em-

phasizing the active role of the learner and refuting the idea of learning suggested by behaviorism (a process of conditioning and association between stimulus and response).¹⁷ The differences are summarized in Table 1. Connecting PBL to the theory of situated cognition is not new. Authors like Gijsselaers,²⁷ Hung,²⁸ Sherly (quoted by Leclerc and Van Der Vleuten⁵), and Hmelo²⁹ had already established this link. But what does situated cognition mean?

a situated learning experience has four major premises: (1) Learning is grounded in the actions of everyday situations; (2) knowledge is acquired situationally; (3) learning is the result of a social process encompassing ways of thinking and perceiving problem solving; and (4) learning is not separated from the world of action. “Knowledge is created or negotiated through the interactions of the learner with others and the environment.”³⁰ In this theory, learning is defined by Seel³² as the “individual’s ability to

Table 1. Learning theories related to PBL

Theory and related authors / PBL	Definition	Basic principles
Cognitivism (Information processing theories) Schmidt; ^{12, 13} Norman & Schmidt; ¹⁴ Charlin, Mann et Hansen ⁷	“Theory of knowledge supported by cognitive psychology which conceives the thought like an information processing center” (translation from Legendre ¹⁸)	Centred on the individual. The mind is an information-processing system beginning with stimulus → sensory register (perception) → working memory → long term memory (encoding and storage) from where retrieval is possible.
Constructivism Savery & Duffy, ¹⁶ Gallagher ²⁰ Hmelo & Evensen; ¹⁵ Friedman & Deek ²¹	“Psychological and philosophical perspective contending that individuals form or construct much of what they learn” (Bruning, Schraw & Ronning 1999) quoted by Schunk. ¹⁹ Constructivism is rather an epistemology, and there are many constructivist theories with two main streams: “cognitive constructivism” related to J. Piaget and “social constructivism” related to Vygotsky. Others authors also as Bruner, Gardner, Goodman and contemporary scientists and psychologists contributed as well. ^{24, 25} But for Phillips ²⁶ it is more complex; constructivism can be compared to a “secular religion with many sects” and an “enormous number of authors, spanning a broad spectrum”.	Individuals are active learners who must construct knowledge for themselves. “Cognitive constructivism”: For Piaget, ²² knowledge construction is a continual process through two mechanisms: assimilation and accommodation, fostered by cognitive conflict. This process begins inside the Individual and leads to development. “Social constructivism”: Vygotsky ²³ outlines the social origin of higher mental processes and stresses the importance of social context. Phillips’ framework for comparing constructivisms: (3 dimensions): 1) about the mechanism of learning construction (biological and psychological/social factors) 2) broad spectrum between “instruction by nature and humans the creators” 3) individual cognition/ social and political processes.

Sources: Schunk,¹⁹ Fosnot,²⁴ Altet,¹⁷ Perry,²⁵ Legendre,¹⁸ Phillips²⁶

Situated cognition or situated learning is “based upon the notion that knowledge is contextually situated and is fundamentally influenced by the activity, context and culture in which it is used”.³⁰ According to Stein,³¹

construct meaning by extracting and organizing information from a given environment”.

These premises can be found in the 6 basic elements of PBL according to Barrows³³ as I represent them in

Table 2: Similarities between PBL and situated learning

Characteristics of PBL (Barrows)³³	Premises of situated cognition (Stein,³¹ Seel³²)
<ol style="list-style-type: none"> 1. Student-centred learning 2. Self-directed learning 3. Learning in small groups 4. Tutor like a guide, a coach 5. Patient-problems constitute the central point of organization and the stimulus of learning 6. Problems are the vehicle for the development of skills of resolution of the clinical problems 	<ol style="list-style-type: none"> 1-2: Learning is individual ability to construct meaning 3-4: Learning occurs in interaction (with peers, tutors and various tools). Learning is a social process. 5-6: Learning is grounded (in a medical problem like those met by physicians in their everyday practice). Knowledge is acquired situationally.

Table 2. One can see the ideas of Barrows et al. also fit in with this theoretical framework of situated cognition, which enables us to look at PBL in another way.

What are the origins of situated cognition? According to Kirshner and Whitson³⁴ there are two main academic trends of situated cognition, one related to critical anthropology and the social theory of Bourdieu and the other related to the sociocultural theory of Vygotsky, a Soviet psychologist. For better understanding of this theory which belongs to “emergent currents in sociology, psychology, linguistics, and education,”³⁵ I’ll explain a little more about the socio-historical-cultural constructivism of Vygotsky and on some aspects of this group of theories.

Some main ideas arise from the work of Vygotsky. Human capacities are, above all, social constructions mediated by means of tools (with regard to the external world) or signs (with regard to higher psychic functions).^{23, 36} Signs include any artificial stimulus created by man to control his behaviour and that of others: language, writing, algebraic symbols, mnemonic devices, etc.³⁷ They act like psychological instruments that allow the development of the individual from the outside in. This is especially true for the learning process that is perceived as an appropriation of previous social experiences through tools and signs that are historical and cultural products.

In connection with learning, Vygotsky²³ introduced a new concept, that of the “zone of proximal development” (ZPD), that he defined as the difference between a child’s present level of development and the level he attains with the help of an adult. He emphasized the role of collaboration and imitation that make it possible for a child to attain a higher intellectual level. Two kinds of concepts, the spontaneous concepts of every day and scientific concepts are acquired through instruction in the ZPD, starting from spontaneous concepts in a backward and forward motion from concrete to abstract. Although

Vygotsky himself concentrated on the process of a child’s learning, his collaborators’ work on various age brackets showed that the formation of concepts obeyed the same basic rules.

According to Rogoff & Wertsch,³⁸ the use in the Occident of the concept of ZPD was the source of the development of new concepts in education such as scaffolding,³⁹ inter subjectivity and the functional dynamic system, concepts to which I’ll return in my results’ analysis. For the neo-Vygotskian³⁴ Newman, Griffin & Cole, this concept of ZPD is seen in a broader sense: “More generally the concept of ZPD refers to an interactive system within which people work on a problem which at least one of them could not alone work on effectively”⁴⁰.

As for the contribution of anthropology, it was marked by Lave’s work,⁴¹ who emphasized the importance of the context of practice in learning. Learning is gradually built in this environment of practice in a process of “legitimate peripheral participation,” that is not at all belittling because the learner keeps all his inventiveness.

Referring again to Lave’s theory of incorporation in a community of practice, Lemke⁴² emphasized that any human community is a particular kind of complex ecosystem, in which all immaterial and material components interact. To become a full member, it is not enough to take part but is also necessary “to be informed of their mysteries”. Thus he noticed two communities of practice, one of schools and one of professional practice bound by networks. Raising the problem of the unit of analysis, Lemke⁴² stressed that in this model of a social ecosystem, the first unit of analysis is neither things nor people but the process based upon interactions.

Another contribution by Brown, Collins and Duguid⁴³ suggested the cognitive apprenticeship approach. They emphasized the importance of “authentic activities”

to promote learning, activities corresponding to the ordinary practices of a culture. According to these authors, learning would, to an extent, be a process of “enculturation” that would be done in a collaborative manner with the help of social interaction. This progressive process relies, on one hand, on the central nature of the activity of learning and, on the other, on the “paradigm of situated modelling.” This enculturation would be valid both for manual training that relies on tools and for the learning of tool-like concepts that “also reflect the accumulated wisdom of the culture in which they are used.”⁴³

There are other elements of situated cognition that we did not raise here, but Moro³⁵ gave an exhaustive overview of these theories. Moreover, they are subject of many criticisms,⁴⁴ especially about the problem of transfer.⁴⁵ Bereiter,⁴⁶ for example, argued that putting students in the same situated context of learning does not automatically guarantee knowledge transfer; it would take place only if students succeed in establishing the link between the concrete and symbolic system. Another criticism advanced by Fenwick⁴⁵ is the idealization of communities of learning because there are cases where learners learned wrong things, false values. The notion of power within human communities can also impair learning.

There are few works on PBL in medicine referring to situated cognition. In the area of teachers’ training I identified an article by Gervais and Loiola⁴⁷ who analysed the practical training of teachers in North America while referring to the theoretical framework of situated cognition. For these authors, the theories of situated cognition can be found within a conceptual framework in three dimensions: the cultural, historical and contextual dimensions of knowledge acquisition.

The contextual dimension takes into account the common setting of the activity in which learning takes root. The cultural dimension accounts for the cultural characteristics found in the learning community identified by its history, values, laws and cultural artefacts or tools in the broad sense. Finally, the historical dimension takes into account that throughout the history of humanity there are interactions with the surrounding sociocultural practices in a reciprocal shaping. In this last dimension three levels should be considered: individual, community and, finally, mankind. These authors describe two aspects of teachers’ training: one theoretical at the university and the other practical in the school setting with certain structuring components.

I found similarities with medical curricula, of which the first two years are rather theoretical (but connected to the medical problems in PBL) and the following years

much more practical. I thus chose the conceptual framework of situated cognition proposed by these authors for my work’s analysis. The “ecosocial system” of PBL will be my unit of analysis, and I’ll emphasize the process in the way presented by Lemke.⁴²

Context

My Master’s degree work was aimed at understanding the adaptation of the PBL approach in the first two years at the faculty of medicine of the Université de Montréal. At this faculty a hybrid curriculum based on PBL was set up in 1993 following the report of the GPEP (General Professional Education of Physicians) panel about training physicians of the 21st century.⁹

Vincelette & Al¹⁰ reported in the pilot project report that the approach adopted by faculty of medicine of Montreal for the first two years was based on the Maastricht model (70%), on the introduction to clinical medicine (20%) and 10% on different other forms of teaching.

The MD program lasts four years and is preceded by a preparatory year for students from CEGEPs (colleges of general and professional education). Some students with a bachelor’s degree in biomedical or para-medical sciences can be directly accepted in the first year. The first two years include 16 mandatory courses that are generally given on campus in form of PBL and four clinical medicine courses offered in a hospital one day per week.

PBL meetings take place twice a week: on Mondays and Thursdays for first year students and on Tuesdays and Fridays for second year students. Nineteen PBL tutorial groups addressing the same problem take place simultaneously in order to maintain an average ratio of one tutor per eight students. These students come from various origins (Canada is a multicultural country) and have a diversified learning background. As for the tutors, 20% are teachers in basic science disciplines and 80% are clinicians, a majority of whom (80%) are specialists.⁹

Methods

I performed descriptive, qualitative research based on the case study method. This approach makes it possible to describe the norm.⁴⁸ Here, the typical case represents the typical, general model of PBL application.

The typical case is built from an intentional non-probabilistic sample of a few cases that are deemed to be representative of the whole.⁴⁹ Of the 19 simultaneous tutorials, I selected one at random each time, on condition that I would be accepted as an observer. I decided

when to stop my observations based on the principle of saturation, which is reached when observation periods do not contribute anything new and data become repetitive.⁴⁹ Saturation occurred after 15 hours of observation, corresponding to five tutorials.

Data were collected through non-participating systematic observation of PBL tutorials in February and March 2004. As much as possible, I noted everything that took place in my logbook.

My results were analyzed through global processing of information comparing my general model of PBL to the conceptual model of situated cognition I had chosen.

Results

A typical PBL tutorial consists of 7 to 10 students meeting with a tutor to discuss either a true or fictional medical problem. It takes place on the campus and in-

cludes 2 phases of the group's working together for 90 minutes each (phase I and III), separated by a 3-day period of individual work (phase II).

Phase I: The first part of the 90-minute meeting is devoted to a brief return to the problem of the preceding session. After 15 minutes, the new problem is tackled. I identified the following 7 stages in the Phase I meeting:

1. Reading of the problem in turns by students, each one reading a part.
2. Sharing of the roles: an organiser, a secretary and a scribe going to the writing board.
3. Clarification of problem's terms by discussion and use of textbooks and dictionaries. Sometimes the group uses the computer or documents prepared by faculty to help comprehension (for

Table 3: Complete analysis of Jos. C. problem (students' suggested explanations are given in *italics*)

Problem: Man 60 years old diabetic with sensitivity problems and sexual, retinal and motor troubles.		
<ul style="list-style-type: none"> • numbness of feet, burning sensation paresthesia, dysesthesia <i>-peripheral neuropathy related to diabetes</i> <i>-Radiculopathy</i> <i>-Alcohol</i> <i>-why pain? Dysesthesia?</i> 	<ul style="list-style-type: none"> • ↓ vibrations in socks to both feet + pb sense of position of toes+ pb touch prick, hypo sweating of the feet <i>-Pb at sympathetic level.</i> <i>problem of fibers connected to the posterior column</i> 	<ul style="list-style-type: none"> • light ↓ distal conduction, motor and sensitive on lower limbs <i>-nerve degeneration</i>
<ul style="list-style-type: none"> • Paresthesia right hand on 3 first fingers+ hypoesthesia <i>-carpal tunnel sd by median nerve lesion</i> <i>-Alcohol</i> 	<ul style="list-style-type: none"> • Hypotrophy short extensor of toes + Ø Achilles tendon reflex <i>-Pb. Low motoneuron</i> <i>To specify</i> 	<ul style="list-style-type: none"> • ↓ sensitive conduction of right median nerve and ↑ motor latency <i>-there are more fast fibers in median nerve</i> <i>-Compression in carpal tunnel</i>
<ul style="list-style-type: none"> • sexual problems (erection + ejaculation) <i>-Involvement parasympathetic and sympathetic systems.</i> <i>-Why are not there urinary signs?</i> <i>-Diabetes/nerves</i> 	<ul style="list-style-type: none"> • Right upper limb: Tinel's sign and Phanel's sign <i>-Stimulation of median nerve compressed, by percussion</i> <i>-Stimulation of tendons</i> 	<ul style="list-style-type: none"> • Denervation of right short extensor of toes (fibrillation at electromyography)
<ul style="list-style-type: none"> • Ø bulbocavernosous reflex 	<ul style="list-style-type: none"> • Retinopathy micro aneurysms hemorrhages exudation <i>- diabetic Retinopathy</i> 	<ul style="list-style-type: none"> • Ø burning sensations at feet with amytriptillin • Viagra ⇒ improvement in sexual dysfunction <i>-Cause vaso dilatation by NO</i> <i>-link with fibers?</i>

Legend: ↓ =reduction, ↑ = increase, NO = nitric oxide, Ø = abolition, Pb= problem, sd = syndrome

- example, images of ascitic patients, histological slides of liver, etc.).
4. Problem's definition that is written on the top of large writing board.
 5. Identification by the group of the main points of the problem that are progressively noted on the writing board (see table 3).
 6. Return to each point identified to try to find explanations. This is a stage of intense activity. Students brain-storm, sometimes referring to the lectures associated with the PBL block, sometimes making links with what they see at the hospital during their clinical immersion day. (Student quote: "*We have been told about infection's role in imbalance of diabetes, so Al's belly pain can be related to an infection.*") They construct their representation of the problem. The tutor asks various kinds of questions to deepen reflection and to direct students towards unraised points (Tutor quote: "*What is osmolarity? What about this factor in the case of Mr G.?*"). The tutor also re-launches the debate when it dries up and focuses students' attention on the problem but seldom gives explanations. Suggested students' explanations are noted under each point of the problem documented (given in italics in Table 3). The gaps perceived by the students and noted progressively on a smaller writing board become topics of learning for individual work. In Table 3, I present an example of the completed problem analysis (Jos.C. problem). The secretary notes this final representation and the

learning topics. These documents will be photocopied and given to each student. In certain cases the representation of the problem was made in the form of a semantic network.

7. Finally the tutor checks in his handbook the list of topics envisaged by faculty. Sometimes students raised them all, sometimes not. At the end of the session, the tutor lists all the objectives envisaged by faculty. (For example, for the problem of Jos. C)

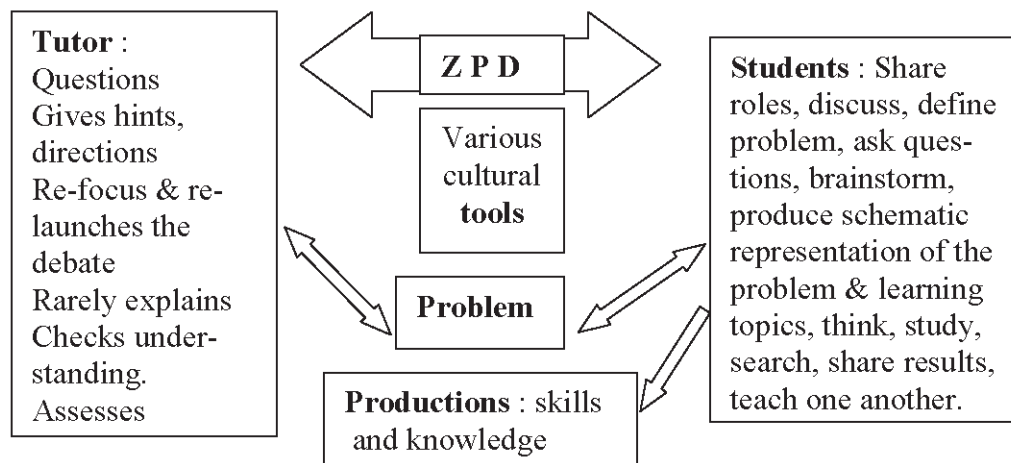
1.Objectives of neuro-anatomy and neurophysiology: Physiology and way of action of sensitive receivers. Physiology and pathophysiology of peripheral nervous fibres. Structure and function of axons and myelin. Nervous conduction. Perception of pain. Diagrams of lumbar plexus and sacred-lumbar plexus. The 5 most significant nerves of the arm. The 5 most significant nerves of the lower limb.

2. Objectives of pathology: Basic physiopathological mechanisms in response to an attack of a peripheral nerve. Physiopathology of alcoholic and diabetic neuropathy. Peripheral neuropathies according to fibres reached and various localizations.

3. Clinical pictures specific to know: Syndrome (sd) of Pancoast. Neuropathy of the median nerve. Sd of the carpal tunnel. Cubital neuropathy, sciatic and peroneal nerves lesions. Sd of meralgia paraesthetica.

4. Treatment Pharmacology of Viagra and erectile dysfunctions.

Figure 1: Typical PBL tutorial



Amitriptylline and diabetic neuropathy, peripheral pain

Phase II, students' individual work, was not investigated. During this time, students use various resources for their learning.

Phase III: Students again read the problem in turns, take again the same roles as in Phase I. They apply the results of their research to the problem by resuming the various points raised during Phase I.

Participation by students is free, but I noted it was unequal. Certain students seemed to have the answer for everything, whereas others simply listened and did not speak, so much so that the tutor had to remind them that they would be graded on their participation. Certain students presented tables and diagrams and shared the references that they found useful. Others expressed difficulties they encountered in understanding one or another point (Student quote: "*I had difficulties understanding slow adaptation and fast adaptation.*") Peers explained to students having difficulties.

The tutor ensured himself of students' comprehension of the significant points by asking questions (Tutor quote: "*Can you specify the role of diabetes in polyneuropathies?*"). Finally, tutor allotted a grade to each student.

A schematic representation of this model of an interactive PBL system with its various components is presented in Figure 1. If we consider Schmidt's "seven jumps"¹², we can see that the tutorial follows these steps. But here, students did not generate classical learning objectives which should be "concise, unambiguous and contain a keyword or headword"⁵⁰; rather, they generated topics of learning. Throughout tutorials participants spoke a lot but briefly and used various tools: books, computer, writing boards.

Analysis and Discussion

I'd like first to outline important limits to my analysis. By the nature of this type of study, my sample is restricted and generalizations are difficult. The typical case study design, however, fitted well with my aim. Moreover, these data were true for 2004; changes may have been brought to this practice since that time.

First, let us consider PBL according to the contextual dimension of learning. PBL tutorials do not take place at the hospital but in small rooms on campus. Students do not deal with a real or simulated patient but with a writ-

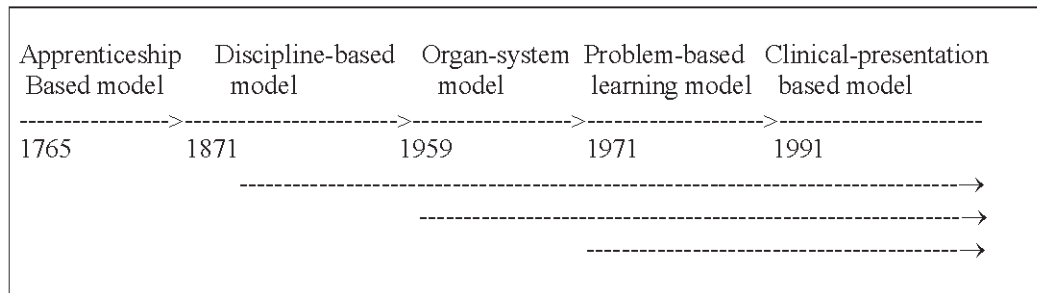
ten case. Can we consider this type of PBL as representing a contextualized learning of medicine? Yes and no. "No", if we look at the model of community of learning with the process of "legitimate peripheral participation" advanced by Lave.⁴¹ Here students do not learn medicine by observing doctors to imitate them with the goal of being transformed gradually through contact with them like an apprentice tailor learns from his master. On the other hand, we can answer "Yes", based on the concept of "cognitive apprenticeship".⁴³ Analyzing problems, trying to understand disease mechanisms, seeking information, making good choices, etc., are all part of the daily intellectual activities of physicians and can be considered as "continuous authentic activities." According to Brown, Collins and Duguid,⁴³ who proposed this theory, authentic activities represent the ordinary activities of a culture and are essential for the development of concepts that are assimilated as tools. We can consider PBL tutorials as authentic activities during which students try to appropriate conceptual tools of the basic and clinical sciences. However, the tutor's role here is rather discrete, and there is often not a "modeling in situation".⁴³ Nevertheless, since students go to the hospital once a week for clinical immersion training, the Université de Montréal model could fit better in the model of double communities presented by Lemke.⁴²

Regarding the cultural dimension of learning, we can analyze the case broadly by referring to tools used in this community as we mentioned previously. These tools are both material and psychological, the first of all being language. Actually, all during the tutorial, language was omnipresent and was the instrument of choice for various interactions. Language was used in its different forms, both verbal and written.

Verbal language is a crucial component of PBL for exchanges and for acquiring medical and scientific terms (such as atrophy, coma, osmolarity, cirrhosis, etc.). It can also translate expressed reflections, a form of verbalised inner language which, according to Vygotsky,²³ enables thought's organisation. Written language, for its part, is first found in the statement of the problem that is also part of the medical culture and serves as the stimulus for learning, according to Barrows.^{3, 33} It is also found in the books and reference works in which medical knowledge is recorded. Finally, it is used to render the fruits of the group's work on board and on paper, which are used to support individual work. One can notice that collaborative work precedes individual learning as described by Vygotsky. In addition to language, technical tools were also used, especially writing boards, computers and audio-visual tools that are the very examples of cultural objects created by man. One can say that interaction among

less well in examinations evaluating basic knowledge in

Figure 2: Chronology of reforms in medical education in North America
(Constructed based on Papa & Harasym⁶¹)



participants through these various tools and instruments creates an interactive system that can be broadly referred to as a “zone of proximal development” (ZPD), as defined by Newman, Griffin & Cole.⁴⁰

Although Vygotsky spoke about ZPD in child education, for Newman, Griffin & Cole,⁴⁰ ZPD is a more general phenomenon that can be observed when two or more people of unequal expertise are jointly performing a task.⁴⁰ It is true that the tutor’s role is rather discrete, but his interventions nevertheless enabled students to cover points that they would not have brought up on their own. Actually, Dolmans & al.⁵¹ showed that students on their own found only 64% of the learning objectives defined by the faculty.

One can see a kind of “scaffolding” that Wood, Bruner and Ross defined as “the process that enables a child or a novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts”.³⁹ These authors describe 6 main functions in scaffolding: “recruitment (enlist interest), reduction in degrees of freedom, direction maintenance, marking critical features, frustration control and demonstration or modelling solutions to a task (may also involve completion or even explication).”³⁹ In PBL tutorials, self-directed learning is emphasized. It can seem contradictory to talk about traditional scaffolding in the context of PBL as noted by Greening;⁵² however, for him, this scaffolding already exists in other parts of the PBL process. In my research I’ve noticed that tutors use many functions of scaffolding as defined by Wood, Bruner and Ross³⁹ (see Table 4), though they avoid demonstration and modelling. But is this scaffolding always sufficient?

This question is called for considering the results of various meta- analyses regarding PBL. In this light, Albanese and Mitchell,⁵⁵ just like Blake and Vernon,⁵⁶ emphasized that students trained using PBL performed

the fundamental sciences. The recent meta-analysis by Gijbels et al.⁵⁷ that analyzed PBL results from the angle of assessment also suggests that PBL students are less successful in tests evaluating comprehension of concepts, though the difference was not statistically significant. In Canada, however, Kaufman and Mann⁵⁸ found no difference, as did Prince et al.⁵⁹ at Maastricht. One can thus say there is a controversy about learning basic scientific concepts.

Returning to our theoretical framework of situated cognition, the process of concept formation, according to Vygotsky’s theses,²³ that is set in motion but not necessarily completed by dealing with a problem, could partly explain these findings. Feltovitch, Spiro & Coulson⁶⁰ also outlined the complexity of biomedical concepts and the necessity to find means to help students correctly. Hence we see the importance of tutor’s modelling stressed by Brown, Collins & Duguid⁴³

To conclude our analysis, let us consider PBL according to historical dimension of learning. For Gervais & Loiola,⁴⁷ individuals and culture shape each other mutually throughout history. In this historical dimension, one should consider three levels: the individual, the community and finally, encompassing all mankind.

At the level of the medical community, PBL is an illustration of the historical evolution of medical education. Papa and Harasym,⁶¹ for example, identified five great periods in medical education in North America since the opening of the first medical school in 1765. A schematic representation is presented in Figure 2. In this context of historical evolution, one can see that even PBL is being overtaken. Some authors such as Herreid⁶² have written about the death of PBL.

Table 4: “Scaffolding” in PBL

Functions of scaffolding ³⁹	Tutoring in PBL
Recruitment (enlist problem solver’s interest)	An effective tutor should be able to stimulate the group’s learning process, ⁵³ helped by good problems that should also stimulate interest ⁴
Reduction in degrees of freedom (reducing alternative movements during skills acquisition, reducing the size of the task)	Learning topics are pre-determined by faculty but students are free, generating their own learning issues.
Direction maintenance (involves keeping the goal of activity, helping to attain new steps)	Tutor keeps students focused on the problem, asks questions to direct them towards unraised topics and to deepen the debate and re-launch it
Marking critical features (accentuating certain features, providing relevant feedback)	The tutor insists on main points. Unfortunately, feedback is not always relevant due to lack of time and, as noted by Maudsley, ⁵⁴ a tutor can’t be an expert in all disciplines of the basic sciences
Frustration control (reduce stress, accept errors but risk creating too much dependency on the tutor)	Tutor is trained to create a good group climate and to not hinder the students’ learning process. But it is not easy, and expert tutors give explanations sometimes.
Demonstration (demonstrating or modelling solutions to a task). Modelling has many faces	Tutor generally avoids modelling.

However, there is an undeniable result of PBL that should not be concealed: improvement of long-term retention. According to Schmidt and Moust,⁶³ this retention is five times greater at the end of six months for students trained by PBL compared to others. This could also partly be explained by the development of concepts. According to Vygotsky,²³ correctly acquired scientific concepts have a life and will live for a lifetime. Howe⁶⁴ wrote, referring to Vygotsky, “they [concepts] are always part of a system of relationships and, as such, are built up over time”.

At the individual level, PBL tutorials enable individuals, students and the tutor with a specific history to interact with each other. This heterogeneity can be a source of enrichment by introducing complementary points of view, but it can also explain the lack of paucity of participation by some students that was noted earlier in my results and noticed also by Duek⁶⁵ and Visschers-Pleijers & al.⁶⁶ What could account for this? Did the students lack the prerequisite knowledge? Were they in “quiet elaboration”?⁶³ Were they in “dysjunction” (defined by Savin-Baden⁶⁷ as a phenomenon experienced by certain students with self doubt and the possibility of frustration and confusion)? I did not pay particular attention to tutors’ background. They were not necessarily content experts but followed faculty’s directives, including special training for tutors.¹⁰

Finally, at the level of mankind, PBL appeared at a time when humanity had put behind it the major world wars and embarked on an unprecedented period of technical and cultural development. With this increase in knowledge in all fields,⁶⁸ it was necessary to find other learning methods involving students in the logic of life-long learning. PBL lends itself to that well. However, as Shulman⁶⁹ said, PBL is not a panacea but an active pedagogic approach that should be used appropriately.

Conclusion

This study revealed the particularities of the hybrid adaptation of PBL at the Faculty of Medicine of the University of Montreal, which is partially based on the Maas-tricht model. According to situated cognition theory, this practice of PBL can be connected to the concept of cognitive apprenticeship of Brown, Collins and Duguid, but the tutor’s role is more discrete than in the cognitive apprenticeship model. In spite of controversies, PBL remains an approach worthy of interest, enabling “co-construction”⁶⁶ of knowledge and skills within a “zone of proximal development”⁴⁰ in the broad sense. But tutors should grant more attention to each student, as the concept of scaffolding suggests, to help all students acquire solid concepts.

It could be also interesting to re-examine the process of having results of individual research and the way of assessing students to improve all students' involvement. Finally, this study also provided another look at PBL as a cultural tool that can be improved.

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