

Reconceptualising problem-based learning in a Vygotskian framework

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Abstract

Background: Problem-based learning (PBL) is widely accepted as an educational approach that allows students to cope with a growing and dynamic body of knowledge and also to learn ways of applying this knowledge to real life practice situations. However, there is a growing sense that the theoretical basis underlying PBL is inadequate, and that this is preventing progress in understanding and developing PBL for future generations.

Discussion: In this paper we advocate the adoption of ideas from the Russian

psychologist, Lev Vygotsky, in the study of PBL. Some relevant constructs include the artefact-mediated nature of human consciousness and the 'zone of proximal development'. These ideas can be combined with Vygotsky's emphasis on a developmental approach and his use of dialectics. Vygotskian ideas offer a way to develop a theoretical framework that can provide much-needed conceptual breadth and depth in the study and future progress of PBL.

Keywords: Vygotsky, problem-based learning, psychological tools, sociocultural, cultural-historical, zone of proximal development, dialectics.

Introduction

Problem-based learning (PBL) is now a key feature of education in many health care professions, and it continues to spread and grow in influence. Its rapid acceptance in many institutions around the world in just a few decades

has been remarkable. This has occurred despite frequent resistance from more conservative teachers and the considerable work and cost required in reorganising curricula around a new approach. It is widely perceived as a solution to many of the difficulties confronting those with the mission of preparing people for the complex tasks of professional practice in a great variety of disciplines, both in and outside the health care professions. However, like all educational interventions, it is not the solution for every situation. There is still much controversy surrounding PBL itself: what it achieves, how it works, and the ways in which it can be improved. To establish the efficacy or otherwise of PBL

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we, as educators, have an obligation to research it in a rigorous manner that will also show us the ways in which it might be adapted and improved. However, to do this we need a credible theory of PBL as a system and process so that we can adequately conceptualise how it functions and devise ways to improve its operation. It is widely accepted that current theories of how PBL works are limited (Bligh 2000; Colliver 2000; Norman & Schmidt 2000). It is our contention that adopting ideas from the Russian developmental psychologist, Lev Vygotsky, can provide some of the conceptual depth and breadth required, if we are to better understand PBL and to conduct research that can provide us with the insights we need to improve the education of health care professionals.

PBL history

PBL in medical curricula originated at McMaster University in Ontario which opened a new medical school in 1969. PBL was a central part of the new curriculum (Neufeld & Barrows 1974). The notion quickly spread to some of the newer medical schools, such as Newcastle, Australia. PBL gained further credibility when Harvard, a well-established institution, adopted PBL in 1985 (Tosteson 1990). The idea was then more widely taken up around the world (Johnson & Finucane 2000).

The early adopters quickly appreciated the promise of the PBL approach over more traditional education. PBL was seen as a way of coping with the 'information explosion' by helping students learn to combine content from different subject areas in solving clinical problems in classroom-supported situations. For decades scientific research

has been increasing the amount and complexity of health-related knowledge and clinical data. The older, department-based approach to professional education was largely content-driven, with students seen as 'blank slates' needing to be filled with scientific information that could make them better practitioners. Departments were reluctant to surrender teaching time to each other, each seeing its discipline and growing body of knowledge as essential to professional practice. According to the UK General Medical Council (1993) there were reports as far back as 1863 that medical courses in particular were too content-heavy and that new graduates had difficulty applying the information they had learned to professional practice. PBL was perceived as a way of coping with all of these problems. Knowledge from different disciplines could now be integrated, and in a manner that encouraged its application to realistic problems that new practitioners could expect to encounter in their professional practice. Champions such as Howard Barrows (Barrows 1994; Barrows & Tamblyn 1980) developed PBL into a formal teaching and learning method and began what was essentially a revolution in health care education.

PBL and theory

At first PBL lacked a theory of how it worked and what was happening during the process. For example, Spaulding and Cochran (1991) describe using the PBL approach simply as a pragmatic means of improving the educational experience. Researchers rapidly took an interest in PBL, and the theories and methods applied to PBL have reflected the prevalent theories and methods

of the time. Many researchers applied cognitive psychology to PBL and used the experimental approach consistent with this discipline (Norman & Schmidt 1992). Others borrowed statistical approaches from disciplines such as epidemiology to try and quantitatively compare PBL with the more traditional educational methods (O'Neill, Morris & Baxter 2000).

This body of research led to a number of findings that have shaped the way many educators think about PBL and the ways it might be improved. For example, it is now widely held that PBL teaches students to adopt a deep rather than a surface approach to learning (Norman & Schmidt 1992) and to use a hypothetico-deductive style of clinical reasoning. The initial problem is used to 'trigger' students to identify a number of hypotheses. Data about the case are then gathered and used to support or reject the various hypotheses until a final diagnosis is reached. This process has been related to the literature on expertise research (Norman & Schmidt 2000) where it is now widely believed that experts think in a forward-directed manner, gathering evidence and eventually reaching a conclusion; whereas novices apparently seize upon a conclusion early and gather evidence to support it. The novice's backward-directed reasoning works well if the original selection is correct. However, if the selection is wrong then the whole process must begin again. It is believed that PBL can encourage the more expert inductive approach to diagnosis and problem solving as well as the deductive skills of hypothesis testing.

PBL controversy

In recent years these claims about PBL have been challenged. A good example is the controversy provoked by a paper from Colliver (2000). Colliver identified two issues of concern with PBL. One was the effectiveness of PBL for knowledge acquisition and clinical performance. The other was the weakness of the links between PBL research and underlying educational theory, especially in terms of cognitive mechanisms. His conclusion was that there was no evidence that PBL improved either outcome. Colliver did concede that challenge, motivation and enjoyment of learning were much improved in a PBL environment. This paper provoked considerable debate (Albanese 2000; Bligh 2000; Norman & Schmidt 2000). Albanese claimed that it was unrealistic of Colliver to expect PBL to demonstrate the significant changes in performance that he demanded. We could add that the students in many courses are so highly motivated that they will do well despite the education they receive, which also makes comparisons difficult. Norman and Schmidt (2000) agreed with Colliver that the use of randomised controlled testing to evaluate PBL was inadequate and advocated a wider range of research variables and designs. However, the attempts to respond to Colliver's contention of the weakness of the underlying theory of PBL were themselves weak. Albanese proposed four theories that could be used: information processing, cooperative learning, self-determination theory and control theory. Unfortunately, these theories are narrowly focused and individually limited in their explanatory power. There is little relation between them

and no indication how any of them might form a comprehensive framework for understanding PBL. Norman and Schmidt (2000) proposed structural equation modelling as a way forward. Unfortunately, this does little to advance theoretical understanding of PBL. Dividing the world into variables and subvariables that might be statistically linked involves a metaphysical assumption that the world can always be explained with this atomistic statistical approach. Norman and Schmidt advised, 'we must take a cue from the natural sciences (2000:726). This may be true of research in the natural world, but there is considerable argument that the social world requires different frameworks for investigation (Denzin & Lincoln 1994; Skinner 1985). Humans are intentional beings for whom things in the world have a meaning, and this needs to be considered when researching human activity. In the debate discussed above this feature did not appear to be a consideration. Bligh (2000) noted that all the participants in the debate concurred that more research was needed and a stronger theoretical base required. A problem with the suggestions made about possible theoretical advances are that they are evolutionary, and assume that theoretical change can be achieved within the existing paradigm which is largely based on cognitive sciences. This cognitive paradigm is based upon a metaphor of clinical reasoning as computation; it has no role for emotion, context or intentionality. We suggest that what might be needed is a more revolutionary change with a shift to a different paradigm, and we suggest a paradigm informed by the cultural-historical ideas of the Russian psychologist, Lev Vygotsky.

Lev Vygotsky

Lev Semonovich Vygotsky (1896-1934) was a polymath with a wide range of interests from art and literary criticism to law, medicine and developmental psychology. In his short life he was a prolific writer and his collected works (Rieber 1997, 1998, 1999; Rieber & Carton 1987; Rieber, Knox & Carton 1993; Rieber & Wollock 1997) are



Lev Vygotsky 1896-1934

now in their sixth volume. In the last few years of his life he fell foul of the Stalinist regime and his work was suppressed in his native Russia for many years, after his death from tuberculosis. Eventually his work was rehabilitated in his homeland, and some years later began to appear in translation in the West. Notable publications were *Thought and Language* which appeared in English in 1962, followed by *Mind in Society* in 1978. Since then there has been a steady flow of Vygotsky's work into the Western world. His

influence has been steadily growing and his works have started to affect fields as diverse as educational psychology, workplace studies and human–computer interaction (Bannon 1990; Cole 1996; Engeström & Middleton 1996). Even though his work is now more than 70 years old it is remarkably fresh and relevant to many contemporary problems.

It is our contention that many of his ideas have the potential to advance the theoretical basis of PBL. Vygotsky's ideas are often described as sociocultural. However, he preferred the term cultural–historical. The latter term emphasises the role of culture and the life histories and personal narratives that people bring with them to any encounter, such as to a PBL tutorial and to the clinical reasoning in real-life practice situations. Many of his ideas revolve around the central thesis that human beings are products of their culture, and that individual psychological characteristics, especially higher level abilities such as the ability to engage in clinical reasoning, are derived from social interaction. These abilities have their origins in 'the external processes of social life, in the social and historical forms of human existence' (Luria 1981:25). This viewpoint is in direct contrast to the assumption in cognitivism that these higher level cognitive skills should be viewed primarily as characteristics of the individual. In Vygotsky's cultural–historical approach, analytic priority is given to social processes. The social processes can be summed up in his notion of and emphasis on culture.

In the Vygotskian view, culture is more than merely a set of interconnected rules and norms. It is a body of knowledge

of the world where knowledge elements are only semi-connected, and from which people learn satisfactory ways of acting by a process of negotiation and interpretation (Bruner 1987). Hutchins (1995) emphasised that culture should be thought of as a process, the human cognitive process in which our everyday practices are enacted. We would add that other dimensions such as emotions and spirituality are embedded in notions and practices of culture. In this view, culture is a process in which we all participate. Many of these ideas have direct relevance to PBL. Some of Vygotsky's ideas which are relevant to PBL are discussed below.

The zone of proximal development

The zone of proximal development (ZPD) is defined as:

The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky 1978:86).

Readers who are actively involved in PBL tutoring or organisation should instantly recognise this as a description of a PBL situation. The students solve a realistic problem with the aid of the tutor. The tutor provides the scaffolding that enables the students to 'reach above themselves' or advance from their current developmental level (current capabilities) to the higher level of a practising and experienced professional. This could be described as reaching their potential (which is in itself an evolving point or level of

achievement). To explore this concept in relation to learning, it can be said that learners, at any point in time, exist in a zone or range of potential development possibilities that can be achieved when facilitated by mentors, peers and others who interact with them within this zone. The ZPD is used to help learners identify the knowledge required and discover how it must be processed in order to achieve goals at the higher level. The tutor also encourages metacognition, so that students consider their problem-solving skills and how they have been used. These are also central features of PBL. When a group of students come from varied backgrounds, particular members can and do adopt the role of 'more capable peers', providing input into the ZPDs of others, including the tutor.

Some implications arise from this sociocultural way of viewing PBL. The education of health care professionals should be viewed as a process of acculturation into a profession (Cant & Higgs 1999). Based on the idea that professional culture is constantly being recreated, reinterpreted and renegotiated by its members, Bruner (1997) argues, there is a need for educators to view educational experiences as providing a forum for negotiating and renegotiating meaning and explicating action, rather than a process of providing information and a set of rules or specifications for action. As educators we want future generations in our professions to become more competent and more knowledgeable than our current generation, in order to advance our professions. If this is to happen our students will need opportunities to negotiate and reinterpret the culture of

their profession and its knowledge base so that they can make it their own and eventually improve it. The PBL situation conceptualised as a zone of proximal development provides an excellent forum for this to happen.

Psychological tools

Another idea permeating Vygotsky's writing is the notion of tools or artefacts, and this is closely related to the importance of culture (Kozulin 1998). Vygotsky believed that our cognition is mediated via artefacts. Our sociocultural environment provides us with a variety of artefacts. These range from physical tools to perform our roles and tasks to symbol systems that can be regarded as psychological tools. The artefacts and tools mentioned by Vygotsky (1981:137) include 'various systems for counting; mnemonic techniques; algebraic symbol systems; works of art; writing; schemes, diagrams, maps and mechanical drawings; all sorts of conventional signs, and so on'. By far the most important artefact for psychological development and learning is language, the tool of tools (Cole & Wertsch, 1996). Vygotsky placed great emphasis on the centrality of language, and the notion that language acquisition opens the way to conceptual thinking. The insight this provides for PBL practice and research is that professional education is primarily about learning and using the language of the profession. Having a language changes the way we perceive reality. Wittgenstein also took this view when he spoke of the 'language games' we use that allow us to inhabit particular 'forms of life' (Wittgenstein 1958). A profession is a form of life with its own language game. Words can expand our

consciousness but can also limit us, as we can only fully express those aspects of experience for which we have words. Language, in turn, gives access to all the other psychological tools of a profession. These tools can range from knowledge of anatomy to knowledge of how to interpret a haematological test result or educate a patient. One of the vital learning outcomes for students in PBL classes is the acquisition and facility in use of the language of their profession. Understanding how such language is a key to learning and performance can be enhanced by examination of Vygotsky's propositions concerning artefacts and the related language arguments of Wittgenstein.

A dialectical approach

Throughout his work Vygotsky advocated a dialectical approach to the study of human activity and psychology. This is in contrast to the approach of the cognitive sciences that assumes we can divide the world up into systems of discrete variables and subvariables. In a dialectical approach, an idea (a thesis) needs to be compared with an opposing idea (an antithesis) until a resolution (a synthesis) is achieved. The resolution is not simply the sum of its parts but is qualitatively different from them. From a Vygotskian perspective, dialectical pairs can be thought/language, social/individual, biological/cultural and immediate experience/mediated memory. The dialectical approach entails identifying the tension in the relationships between these things, and seeing them as the unity of diverse processes rather than as distinct unities or discrete variables. In a dialectical view, psychological

phenomena interpenetrate each other and are internally related rather than discrete (Ratner 1991). The implication is that complex higher mental processes such as clinical reasoning are not the sum of the lower level mental processes they begin with. Clinical reasoning ability may begin with everyday thinking and problem solving skills, but as it develops it becomes transformed and qualitatively different, and should be recognised as an increasingly complex phenomenon comprising interrelated dimensions including dialectical goals (of the patient/clinician, health promotion/remediation) and dialectical processes (helping/letting go, listening/educating, evaluating/advising). In clinical decision-making that involves human beings there is often much that depends on the situation, the goals of different people and other such complex parameters; rarely are such clinical decisions black and white. In this view, high-level statistical modelling between sets of variables would be an inadequate means of seeking to understand clinical reasoning in practice, and also to explain the learning, practice and articulation of clinical reasoning that occurs in PBL. In PBL sessions, with the opportunity to 'unbundle' complex problems and to reflect on the imprecision of clinical practice and people's lives, promotion of discussion of these dialectics could provide a valuable learning tool.

A developmental approach

Using cultural-historical and dialectical approaches encourages a focus on development. To understand many phenomena we need to also understand how they came to be how and what they are. Vygotsky believed that, during

the early twentieth century when he was writing, psychology was in a 'pre-Darwinian' phase, preoccupied with superficial appearances, and that it needed to turn to an examination of how psychological phenomena (like clinical reasoning) developed. In biology, before Darwin, the preoccupation with taxonomy based on superficial description led to misunderstandings such as classifying whales and fish together. With the Darwinian turn to evolution and development, biology forged ahead as a science, and Vygotsky believed this needed to happen in psychology.

When Darwin created his remarkable evolutionary theory, he created the possibility for moving from a phenotypical to a conditional-genetic [developmental] perspective. What happened to biology at this point is something which every science has gone through or ought to go through. (Rieber et al 1993:247)

It could be argued that this observation is still relevant today. Cognitive psychology tends to focus on the mature forms of cognitive abilities and is a poor tool for studying how these abilities develop. In PBL, students do not come equipped with the well-developed clinical reasoning skills of experts; they need to develop them. PBL is in essence and aspiration a developmental process.

The search for a method

The question then arises: How might researchers embark upon the study of what is happening in PBL? The search for an appropriate method

for examining human phenomena concerned Vygotsky throughout his life. Although he certainly conducted some elegant experiments he also realised the limitations of the experimental approach:

Blind transportation of the experiment, the mathematical method from the natural sciences, created in psychology the outward appearances of science, under which, in reality was hidden a complete powerlessness before the phenomena under study. (Vygotsky, cited in Van der Veer & Valsiner 1991: 149).

It can be argued that this criticism is just as apt today as it was in Vygotsky's time, and the issue is still controversial. Mainstream cognitive psychology is still preoccupied with attempting to follow the model of the physical sciences and treat psychological phenomena as entities that are to be measured mathematically. There is a growing dissatisfaction with this approach (Smith, Harré & Van Langenhove 1995) and a search for a rigorous methodology that will allow research to move forward. Researchers inspired by Vygotsky's ideas are learning to adopt an interdisciplinary approach to research, borrowing techniques from disciplines as diverse as anthropology, linguistics and sociology (Rogoff & Chavajay 1995). Both qualitative and quantitative methods are widely employed. Ratner (1997) argued that qualitative methods in particular, such as phenomenology and hermeneutics, offer a way to conduct research that is in keeping with Vygotsky's ideas, allowing phenomena like PBL to be explored in a rigorous manner that brings out the dialectical complexity involved.

Concrete units of analysis can be drawn from developments of Vygotsky's ideas, such as Activity Theory, which was largely developed by Leontyev, a colleague and student of Vygotsky (Tolman 1987; Leontyev 1979). To illustrate the basic components of his Activity Theory, Leontyev used the example of a primitive hunt. There is an overall activity, governed by the motive of getting food. To achieve this, the hunter is engaged in an action, which has the goal of scaring animals toward other hunters. This, in turn, is enabled by the automatic operation of running. Applying an Activity Theory approach to PBL would involve exploring the ways in which the various skills and knowledge needed by students to become proficient health care professionals evolve within their learning framework. The emphasis would be on the dynamic process of development over time.

Discussion

Vygotsky's collected work in translation is now in six volumes. In this short paper we have focused on some of his better-known ideas. His work is essentially constructivist. Notions such as situated learning (Lave & Wenger 1991), scaffolding and cognitive apprenticeships come directly from Vygotsky. Lave and Wenger described learning as 'legitimate peripheral participation'. This is the process by which students are gradually drawn into the practice of a profession, which is precisely what PBL is designed to provide for students. PBL is a safe form of legitimate participation in professional practice with no direct consequences to patients, and provides opportunities for students to explore, ponder, experiment and endeavour to

understand, rather than seeking to learn and recall the right answers. Research influenced by Vygotsky's ideas is already challenging some long-held beliefs about clinical reasoning and learning. For example, some research into expertise in the workplace contradicts the notion that experts reason in a forward-directed manner and novices in a backward manner. Laufer and Glick (1996) showed that in a real-world context experts can often engage in backward reasoning. This finding emerged because the researchers paid attention to problem solving in a real-world context rather than an artificial laboratory situation. In a Vygotskian view, the unit of analysis needs to be a situation in which the inner workings of a phenomenon are preserved in context, allowing it to emerge in all its richness. This notion has inspired a flowering of research adopting an interdisciplinary approach (Chaiklin & Lave 1993).

The cognitive sciences have dominated the discourse about PBL for many years. As its shortcomings become more apparent, a groundswell of opinion has arisen against mainstream cognitive psychology. Jerome Bruner, recognised as one of the 'fathers' of the cognitive revolution, rejected cognitivism some years ago in favour of a more Vygotskian approach (Bruner 1987, 1992, 1997). It can be argued that we are entering a time of paradigm shift, as described by Kuhn (1970). The old paradigm of cognitivism is having to make more and more accommodations for observations that do not fit its model. For example, Hak and Maguire (2000) complained that despite all the research into PBL based on a cognitive model, the phenomenon of PBL was still essentially a 'black box'.

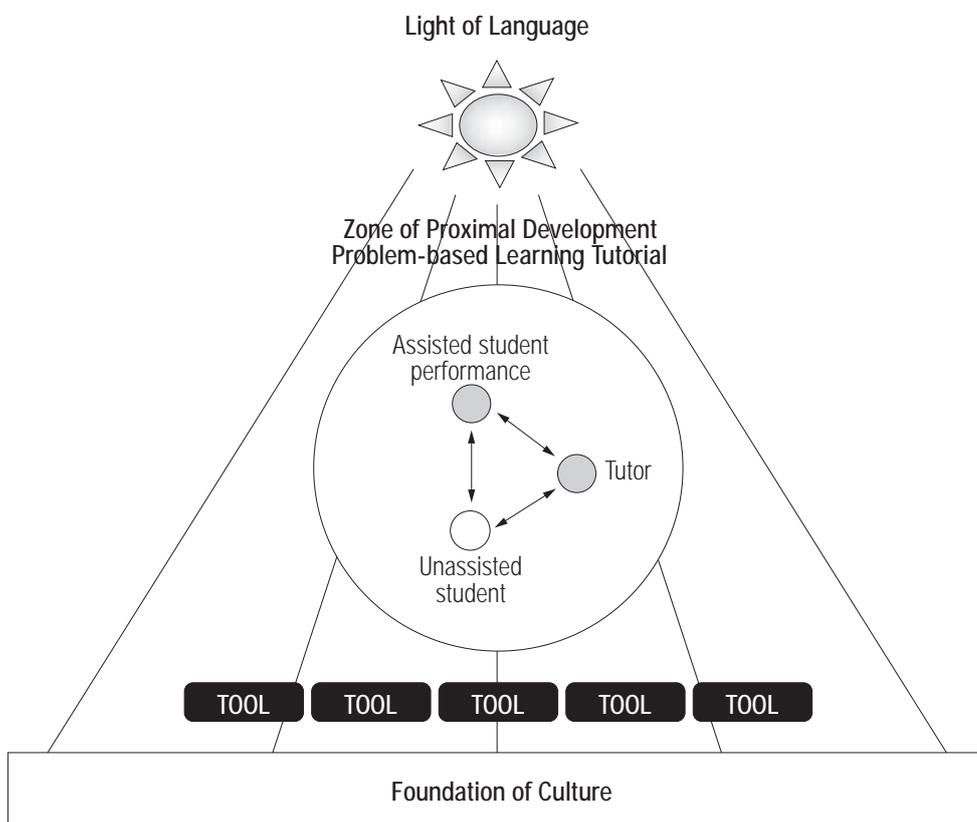


Figure 1: Problem-based learning: A Vygotskian framework

Few researchers have ever looked directly at the process of PBL. This is probably because a cognitive approach, utilising experimental methods out of context, is an extremely limited tool for researching such a complex phenomenon. A newer cultural–historical paradigm informed by Vygotsky’s ideas may provide a better account of the field of study. This does not mean that we have to dismiss all the findings of the previous paradigm. Cognitivism did not reject all the findings of the behaviourism it sought to replace. The notions of establishing objectives for learning

and providing regular feedback came originally from behaviourism, and these are widely accepted as positive aspects of education today. Likewise, adopting a Vygotskian perspective does not necessitate abandoning all the findings of cognitive science. For example, the hypothetico-deductive model has a strength and robustness that supports its retention both as a teaching and learning tool and as an observation of some of the behaviour that occurs in clinical reasoning (and PBL). Over the years this model has been increasingly modified (Higgs & Jones 2000; Edwards

et al 2004) to recognise the importance of context and interaction in decision making. These changes complement the Vygotskian view of PBL.

Figure 1 represents these ideas diagrammatically. Human activity occurs on a foundation of culture which provides a variety of tools, and it occurs in the light of language. The double-headed arrows indicate the dialectical tension and the complex relationships that occur between entities such as tutor and student, and unassisted and assisted performance. Tools can be stethoscopes, radiographs, mnemonics, anatomical knowledge, computers, whiteboards, etcetera.

Conclusion

The implications of Vygotsky's work are still to be fully explored. His ideas offer a fruitful source for those looking for a way to deepen the theoretical basis of PBL and establish a conceptual basis for a better understanding of the PBL phenomenon. Toulmin (1978) described Vygotsky as 'the Mozart of psychology'. There are certainly similarities between Vygotsky and Mozart. Both were geniuses, prolific workers and died tragically young. However, the similarity ends there. Mozart's work was appreciated in his lifetime and has remained popular ever since. Vygotsky and his work languished in obscurity for almost 50 years, and is only beginning to have an impact. As Blanck (1992:31) wrote:

Vygotsky left an impressive body of work that, as is the case with most geniuses, becomes more modern as time goes by. Vygotsky gave a new configuration to psychology's past, proposed

theoretical alternatives to its present, and suggested solutions that became projects for the future. It is only now that the impact of his work is beginning to be felt in the scientific community. His theory is offering answers to questions that seemed insoluble and is setting a course for us to follow. Vygotsky ... speaks to us from the future.

It is our contention that Vygotsky's ideas offer a way of reconceptualising PBL that can provide a richer and deeper theoretical model for PBL than we have at present. This would overcome many of the complaints made about PBL and its research, and provide inspiration for developing PBL for many years to come.

References

- Albanese MA (2000) Problem-Based Learning: Why Curricula Are Likely to Show Little Effect on Knowledge and Clinical Skills. *Medical Education* 34: 729-738.
- Bannon LJ (1990) A Pilgrim's Progress: From Cognitive Science to Cooperative Design. *AI & Society* 4, 4: 259-275.
- Barrows HS (1994) *Practice-Based Learning: Problem-Based Learning Applied to Medical Education*. Springfield, IL, Southern Illinois University School of Medicine.
- Barrows HS, Tamblyn RM (1980). *Problem-Based Learning: An Approach to Medical Education*. New York, Springer Publishing.
- Blanck G (1992) Vygotsky: The man and his cause, in: LC Moll (Ed.) *Vygotsky and Education: Instructional*

- Implications and Applications of Sociohistorical Psychology*. Cambridge, Cambridge University Press, pp. 31-58
- Bligh J (2000) Problem-Based Learning: The Story Continues to Unfold. *Medical Education* 34, 9: 688-689.
- Bruner J (1987) *Actual Minds Possible Worlds*. Cambridge, MA, Harvard University Press.
- Bruner J (1992) *Acts of Meaning*. Cambridge, MA, Harvard University Press.
- Bruner J (1997) *The Culture of Education*. Cambridge, MA, Harvard University Press.
- Cant R, Higgs J (1999) Professional socialisation, in: J Higgs & H Edwards (Eds) *Educating Beginning Practitioners: Challenges for Health Professional Education*, Oxford, Butterworth-Heinemann, pp. 46-51.
- Chaiklin S, Lave J (Eds) (1993) *Understanding Practice: Perspectives on Activity and Context*. Cambridge, Cambridge University Press.
- Cole M (1996) *Cultural Psychology: A Once and Future Discipline*. Cambridge, Mass. Harvard University Press.
- Cole, M., & Wertsch, J. V. (1996). Beyond the Individual-Social Antimony in Discussions of Piaget and Vygotsky. *Human Development*, 39(5), 250-256.
- Colliver JA (2000) Effectiveness of Problem-Based Learning Curricula: Research and Theory. *Academic Medicine* 75: 256-266.
- Denzin NK, Lincoln YS (Eds) (1994), *Handbook of Qualitative Research*. London, Sage Publications.
- Edwards I, Jones MA, Carr J, Braunack-Mayer A, Jensen G (2004) Clinical Reasoning Strategies in Physical Therapy. *Physical Therapy* 84: 312-335.
- Engeström Y, Middleton D (Eds) (1996) *Cognition and Communication at Work*. Cambridge: Cambridge University Press.
- General Medical Council (1993) *Tomorrow's Doctors* London Education Committee of the UK General Medical Council.
- Hak T, Maguire P (2000) Group Process: The Black Box of Studies on Problem Based Learning. *Academic Medicine* 75, 7: 769-772.
- Higgs J, Jones M (2000) Clinical reasoning in the health professions, in: J Higgs & M Jones (Eds) *Clinical Reasoning in the Health Professions*, Oxford, Butterworth-Heinemann, pp. 3-14.
- Hutchins E (1995) *Cognition in the Wild*. Cambridge, MA, MIT Press.
- Johnson SM, Finucane PM (2000) The emergence of problem-based learning in medical education. *Journal of Evaluation in Clinical Practice* 6(3): 281-291
- Kozulin A (1998) *Psychological Tools*, Cambridge, MA, Harvard University Press.
- Kuhn T (1970) *The Structure of Scientific Revolutions* (2nd edn). Chicago, University of Chicago Press.

- Laufer EA, Glick J (1996) Expert and novice differences in cognition and activity: A practical work activity, in: Y Engeström & D Middleton (Eds) *Cognition and Communication at Work*. Cambridge, Cambridge University Press.
- Lave J, Wenger E (1991) *Situated Learning: Legitimate Peripheral Participation*. Cambridge, Cambridge University Press.
- Leontyev, AN (1979) The problem of activity in psychology. In J.V. Wertsch (Ed.). *The concept of activity in Soviet psychology* 37-71. Armonk, NY: Sharpe.
- Luria AR (1981) *Language and Cognition*. New York, Wiley.
- Neufeld VR, Barrows HS (1974) The 'McMaster Philosophy': an approach to medical education. *Journal of Medical Education* 49, 1040-1050
- Norman GR, Schmidt HG (1992) The Psychological Basis of Problem-Based Learning: A Review of the Evidence. *Academic Medicine* 6: 557-565
- Norman GR, Schmidt HG (2000) Effectiveness of Problem-Based Learning Curricula: Theory, Practice and Paper Darts. *Medical Education* 34: 721-728.
- O'Neill PA, Morris J, Baxter C-M (2000) Evaluation of an Integrated Curriculum Using Problem-Based Learning in a Clinical Environment: The Manchester Experience. *Medical Education* 34: 222-230.
- Ratner C (1991) *Vygotsky's Sociohistorical Psychology and its Contemporary Applications*. New York, Plenum.
- Ratner C (1997) *Cultural Psychology and Qualitative Methodology: Theoretical and Empirical Considerations*. New York, Plenum Press.
- Rieber RW (Ed.) (1997) *The Collected Works of L.S. Vygotsky: The History of the Development of Higher Mental Functions (Vol. 4)*. New York, Plenum.
- Rieber RW (Ed.) (1998) *The Collected Works of L.S. Vygotsky: Child Psychology (Vol. 5)*. New York, Plenum.
- Rieber RW (Ed.) (1999) *The Collected Works of L.S. Vygotsky: Scientific Legacy (Vol. 6)*. Amsterdam Kluwer Academic Publishers.
- Rieber RW, Carton AS (Eds.) (1987) *The Collected Works of L.S. Vygotsky: Problems of General Psychology, Including the Volume Thinking and Speech (Vol. 1)*. New York, Plenum Pub Corp.
- Rieber RW, Knox JE, Carton AS (Eds.) (1993) *The Collected Works of L.S. Vygotsky: The Fundamentals of Defectology (Vol. 2)*. Amsterdam Kluwer Academic Publishers.
- Rieber RW, Wollock J (Eds.) (1997) *The Collected Works of L.S. Vygotsky: Problems of the Theory and History of Psychology Including the Chapter on the Crisis in Psychology (Vol. 3)*. New York, Plenum.
- Rogoff B, Chavajay P (1995) What's Become of Research on the Cultural Basis of Cognitive Development? *American Psychologist* 50, 10: 859-877.

- Skinner Q (1985) Introduction: The return of grand theory, in: Q. Skinner (Ed.) *The Return of Grand Theory in the Human Sciences*, Cambridge, Cambridge University Press, pp. 1-20.
- Smith JA, Harré R, Van Langenhove L (Eds.) (1995) *Rethinking Psychology*. Thousand Oaks, CA, Sage Publications.
- Spaulding WB, Cochran J (1991) *Revitalizing Medical Education: McMaster Medical School, The Early Years 1965-1974*. Philadelphia, BC Decker.
- Tosteson DC (1990) New pathways in medical education. *New England Journal of Medicine* 322, 234-238
- Tolman, C.W. (1987). The comparative psychology of A.N. Leontyev -U.S.S.R. In E. Tobach (Ed.). *Historical Perspectives and the International Status of Comparative Psychology* 203-209. Hillsdale: LEA.
- Toulmin S (1978) The Mozart of Psychology. *New York Review of Books* 25, 14: 51-57
- Van der Veer R, Valsiner J (1991) *Understanding Vygotsky: A Quest for Synthesis*. Cambridge, Blackwell.
- Vygotsky LS (1962) *Thought and Language* (E Hanfmann & G Vakar, Trans.). Cambridge, MA, MIT Press.
- Vygotsky LS (1978) *Mind in Society: The Development of the Higher Psychological Processes*. Cambridge, MA, Harvard University Press.
- Vygotsky, L. S. (1981). The instrumental method in psychology. In J. V. Wertsch (Ed.), *The concept of activity in Soviet psychology* (pp. 134-143). Armonk, N.Y.: Sharpe.
- Wittgenstein L (1958) *Philosophical Investigations* (GEM Anscombe, Trans.) (2nd ed.). Oxford, Blackwell.