THE STRATEGIC POINTS OF PROBLEM-BASED LEARNING
– organising curricula and assessment

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Problem-based learning (PBL) has been applied for over twenty years in different fields of education in many countries. The first and best-known applications of PBL are in the study of medicine during the1960s (Barrows 1985; Barrows 1996). Since then PBL has spread worldwide to other disciplines in higher education such as architecture, economics, engineering, mathematics and law. Problem-based learning has often been understood only as a method of learning. What distinguishes PBL as a teaching technique, as an educational strategy, or even as a philosophy are the changes in the whole learning environment that the approach requires. Defining PBL as an educational philosophy means holistically considering a number of elements: the organisational context; curriculum content and design; and the teaching and learning approach, including the method of assessment and evaluation.

Although problem-based learning has been investigated in the context of education, the theoretical basis of PBL is closely connected to learning in the work place. PBL runs the same risks as any other progressive pedagogical idea: the baby might be thrown out with the bath water. PBL can fail, for instance, because of mechanical application, or because no changes have been made on the curriculum level or because the assessment and evaluation sys-

tem has not been developed in response to the new ideas about learning. In this article we examine the basis of PBL knowledge and the prerequisites for the development of curricula and for the assessment of problem-based learning. We conclude the article with the heading 'PBL – bridging work and education' which is the theme of the conference and of this book. The concluding chapter also provides an orientation to the articles in the book.

The basics of problem-based learning

The basic premise of problem-based learning (PBL) is that learning starts from dealing with problems that arise from professional practice. Traditionally, education has been organized according to the logic of separate disciplines and subjects. However, because professional practice and individual learning processes do not follow such divisions, this has led to a widening gap between education and professional practice in the work place (Boud 1985; Boud & Feletti 1991; Poikela, E. & Poikela, S. 1997; Poikela, S. 2003.) PBL gathers and integrates many elements regarded as essential in effective, high quality learning, such as self-directed or autonomous learning, critical and reflective thinking skills, and the integration of disciplines.

In epistemological discussion knowledge is usually divided into theory and practice. Theory is understood as propositional knowledge (knowing-what), and practice as procedural understanding (knowing-how) (Ryle 1949, Eraut 1994). In a broader sense the relationship between knowledge (what) and knowing (how) can be understood as a debate between Cartesian finite and Heideggerian changing knowledge. The former represents the modern idea of permanent knowledge and the latter the post-modern way of apprehending knowledge as changing and dependent on the context of the activity rather than on facts or truth. In PBL knowledge is seen as being more closely aligned to the post-modern than the modern view of epistemology. (Cowdroy 1994.)

Few scholars have attempted to distinguish between the epistemological and ontological dimensions of knowledge. However, Nonaka and Takeuchi (1995) do make this distinction. They argue that the epistemological dimension describes conversion processes from implicit (tacit) to explicit knowledge, and vice versa, from explicit to implicit knowledge. The result of this conversion is new knowledge and a new way of knowing and acting. The ontological dimension, on the other hand, describes knowing processes that take place between an individual, a group and an organisation. Cook and Brown (1999) also make the same kind of distinction between the mode of knowledge and the possession of knowledge. According to them, knowledge can be explicit or implicit and is possessed by an individual or a group. (Poikela, E. & Poikela, S. 2001.)

There are many conventional distinctions between what-knowledge and how-knowledge. The former is evident in expressing propositional or declarative knowledge, and the latter refers to procedural or practical knowledge. These dimensional distinctions are problematic because of the concept of *tacit knowledge*. Individual or shared knowing includes implicit, non-verbal and invisible elements, for example the skills of experts at a high level of competence. Tacit knowledge is hidden in the acting body and in the thinking mind (Zuboff 1988). Cook and Brown (1999) use the expression 'epistemic work' to describe the conversion of tacit knowledge into explicit knowledge and vice versa which takes place between the individual and the group.

Conceptual knowledge in a textual, codified or any other symbolic form is not the same as it is in the memory of an individual, a group or an organisation. Correspondingly, practical knowledge is not only in the possession of a professional, but it can be embedded in artefacts produced by humans or in objects of nature. So, knowledge from theory or praxis is objective because it is not dependent on an individual person (see Figure 1). From the point of view of the learner, practice and theory, like any other kinds of information, are sources of *potential knowledge*, the goal of learning outside her or himself. The integrative knowledge from and between theory and praxis is needed for constructing experience, the mode of subjective experiential knowledge,
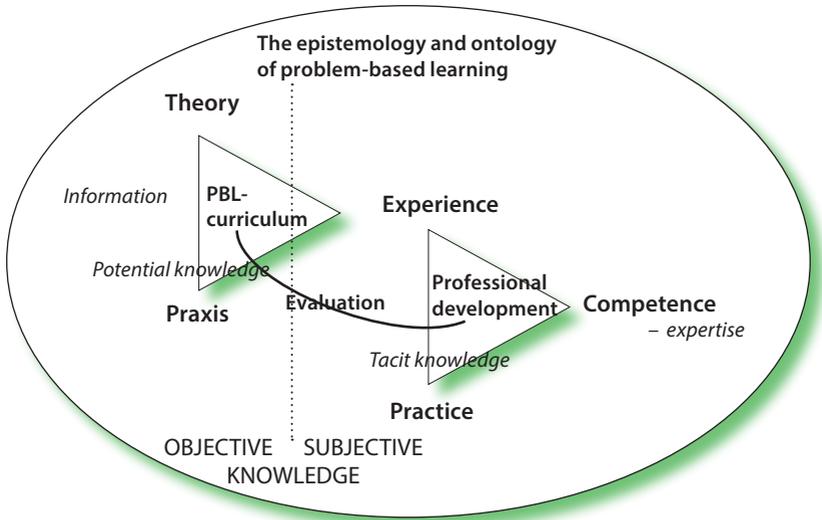
The epistemology and ontology
of problem-based learning

Theory

Information

PBL-
curriculum

Experience

Potential knowledge

Praxis

Evaluation

Professional
development

Competence
– expertise

Tacit knowledge

Practice

OBJECTIVE   SUBJECTIVE
KNOWLEDGE

FIGURE 1. The contextual basis of problem-based learning

including the highly personal elements of *tacit knowledge*. Instead of the traditional two-dimensional description, a three-dimensional view of knowledge consisting of *theory, praxis and experience* should be adopted. Burnard (1987) had the same idea of three defining elements, but only on the subjective dimension: theoretical, practical and experiential knowledge.

In the traditional curriculum practical knowledge is separated from theoretical knowledge. It is impossible for the learner to integrate these two aspects into experiential knowledge. Learners are not able to apply theories and models in order to solve problems in practical situations, and knowledge implanted into the memory is easily forgotten. Correspondingly, emotional events are just experiences; there is no theoretical understanding. Conventional education fails in two areas: firstly, learners will not learn to solve problems in professional practice and secondly, they will not learn skills of 'learning to learn' which are essential in the climate of continuous change that characterises working life and professional development.

In Figure 1 the left-hand triangle depicts what can be achieved through a good education, and the right-hand triangle depicts those skills which can be learned through professional practice. Education itself cannot produce complete professional competence, but there should be an awareness of the dimensions and processes taking place between the *PBL curriculum* and *professional development*, and also pay attention to the meaning of tacit knowledge. *Evaluation* is the means of producing knowledge about those processes which occur between education and working life.

The use of PBL as a tool for the individual teacher has only minor implications for the curriculum, the method of assessment and the education system as a whole. However, defining PBL more as an educational philosophy means adopting a framework which holistically considers a range of elements: the organisational context; curriculum content and design; the teaching and learning approach – understanding PBL as a pedagogy; and the need to develop the curriculum as well as quality systems. This creates new challenges for developing assessment and evaluation at all levels of the curriculum process.

PBL as a strategy for curriculum development

From the postmodern point of view PBL is a strategic answer to the competence needs of the information society (Cowdroy 1994). These competences emphasise the skills of knowledge processing, communication, interaction and problem solving. The shift from knowledge to knowing is reflected in the demand for continuous learning and in the need to repeatedly develop or even change a professional orientation. Education has to be able to respond in a new way to the demands of knowing. It is not enough that education provides sufficient knowledge to be applied in professional practice; education itself has to be able to produce the core competences needed in the future.

A curriculum normally consists of certain points of departure, aims and principles formed by the particular ideology of a specific era. It forms a gen-

eral reference point for discussion and working in the field of education. The basic principles of a curriculum also determine, how the learning environment is organised. (Goodson 1989; Bernstein 1990; Tompkins 2001). The essential characteristics of a PBL curriculum are:

a) The curriculum is organised around problems that are relevant to desired learning outcomes, rather than being organised according to topic or academic discipline.

b) The creation of conditions that promote small-group work, self-directed learning, independent study, contextual knowledge, critical thinking, life-long learning and self-evaluation.

c) The construction of a student-centred learning environment.

Students are allowed to recognise and find knowledge for themselves when approaching the problem and building a bridge between theory and reality (Hannafin & Land 1997). In PBL, knowledge is a subject for perceiving, analysing, integrating and synthesising than rather an object for memorising. Shared knowledge construction is an essential element for producing scientific and multi-professional competence. In PBL-cycles, individual learning (independent knowledge acquisition) and joint learning (setting learning tasks, knowledge sharing and construction in tutorials) are separate processes. Together, these processes can have a profound impact on the development of professional competence.

As a resource and catalyst of learning, the nature of knowledge is *contextual.* It is not only a conceptual, symbolic or formal fact, but it is embedded as potential in objects, artefacts, human activity or in the structure of an organisation. This explains why education should teach students to "read" the context of the future profession – the complex knowledge environment of work. At first sight this might appear to be a recipe for chaos, rather than a well-organized curriculum (see Figure 2). However, the development of this kind of competence does require an organised curriculum (Poikela & Poikela 2001).
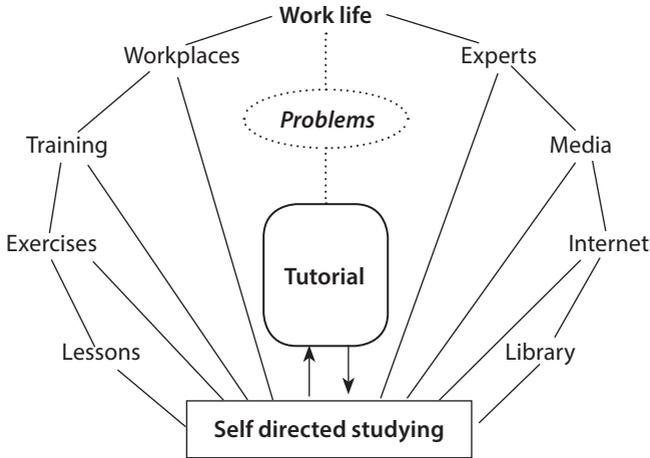
FIGURE 2. The PBL-curriculum as a knowledge and learning environment

The problem-based curriculum should be organised as a student-centered learning environment. In concrete terms, this means knowledge acquisition from books in the library and information seeking from the internet, the media and from professional experts in working life. It means that lessons and exercises in school are no longer causes of learning, but resources for learning. Training connected to workplaces and real work life is an essential means of achieving practical knowing in professions.

Organising evaluation in PBL

There is a common idea about the curriculum directing both teachers' work and students' work. Boud (1995) argues that the curriculum directs only teachers' actions not students' learning. The most powerful means for guiding students' work are assessment procedures. Traditionally, students are

the objects of the assessment, which makes them feel controlled by teachers. Today, students are seen as subjects, not only in learning processes, but in assessment processes, too. This insight highlights the most important difference between traditional learning conceptions and problem-based learning.

The changing evaluation paradigm can be seen as a transition from scientific measurement towards judgemental (qualitative) assessment (see Hager & Butler 1994; Hager 1999). The focus of scientific assessment is only on results, which are measured as objectively as possible. With judgemental assessment, on the other hand, the focus is on the process of producing results. This means that subjective factors can be taken into account, too. Boud (2000) argues that assessment involves identifying appropriate standards and criteria, and making judgments about quality. The meaning and forms of assessment should be extended and seen as an indispensable factor in all forms of lifelong learning.

Esa Poikela (2003, 2004) identifies an analogical relationship between judgmental assessment and contextual analysis. According to Pettigrew (1985), the starting point of analysis is in the description of the process according to the external societal context and the internal organisational context. One of the tasks of analysis is to develop criteria for evaluating activity and its effects on the process. Poikela presents the idea of context-based assessment (CBA) which requires that situational and contextual factors are carefully considered. This offers a very broad perspective on assessment and also facilitates the development of quality systems.

Zones and mirrors for assessment and evaluation

The theoretical basis for developing ideas about contextual assessment and quality systems in problem-based learning can be found in experiential learning. This approach provides a framework and a starting point for further development and research, making explicit good practices and quality factors connected with evaluation and pedagogy.

According to Kolb (1984), reflective observation is an essential part of a learner's activities. In this way, it can be seen as a factor uniting the processes of learning and assessment. The learner is not only the owner of the learning process, but s/he owns the processes of assessment as well. The learner's ability to assess his/her own knowing is the most important factor in understanding and influencing the situation and the context of action. Process assessment creates a basis for guiding self-assessment and for assessing the outcomes or products of learning activities (see Figure 3).

The core of Figure 3 is the cycle of experiential learning with reflective observation as an essential part of the process. Self-assessment is the central zone of the core, process assessment is in the middle and product assessment is in the outer zone. Between them are the boundaries needed for developing the learner's assessment skills. Below, we examine this theoretical framework in the light of Sari Poikela's (2003) research results.
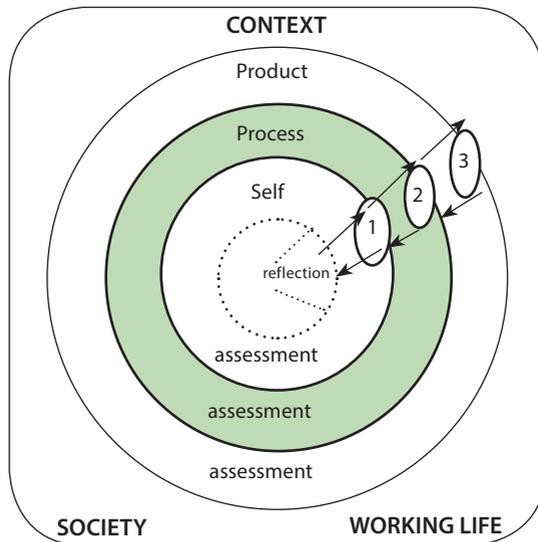

FIGURE 3. The mirrors of the assessment process

The first mirror

The boundary between self- and process assessment provides *a mirror* which helps learners to learn reflective skills for assessing themselves, their performances and their relations to other actors. The most essential mechanism for reflection is *feedback*. Learners can observe themselves and others in action with the help, for example, of the study or work journal. They can receive and consider instant feedback from the supervisor, other students or work colleagues, and from the peer group. Improving self-assessment and process assessment skills is important both for teachers and students. Because PBL demands skills of reflection, interaction and collaboration, effective tools for improving the quality of individual and shared learning processes are needed.

According the study, changes brought about by PBL prompted feelings of uncertainty in both teachers and students. The change and development had to be supported. Otherwise, there seemed to be a risk that both teachers and students would retain their former secure roles, with the result that the so-called change was little more than 'cosmetic'. Students had to be encouraged to take part in self- and group reflection, and these skills had to practised systematically in tutorials (group situations facilitated by a tutor). This was done via systematically given and perceived feedback: peer assessment between tutorial members and the tutor's feedback for individuals and the whole group. Tutorial members also gave feedback to the tutor. Feedback forms, learning journals and discussions were used in this process.

The second mirror

The aim of the mirror between process and product assessment is to examine the means involved in setting goals and the *criteria* for achieving them. Usually the setting of goals and assessment criteria is not carried out in cooperation with the learners. Rather, it is assumed that the learners' task is simply to accept them and act accordingly. In order to improve motivation, com-

mitment and responsibility for reflective learning, the premises and means of assessment need to be made explicit and clear. Even if the criteria already exist, the learners need to recreate them in order to engage in the processes of learning and assessment.

The integration of process and product assessment in the PBL curriculum proved to be problematic. Finding the means of assessing learning outcomes was difficult. Tutors and students wanted to get rid off old methods of assessment such as book exams. 'Soft' means of assessment were desired. Although measuring learning outcomes is necessary, it has to be done in a harmony with the principles of PBL. The worst experiences for students occurred when assessment was conducted in a traditional way that undermined the credibility of the entire process of curriculum reform. Students were not involved in the process of creating the criteria for assessment. Teachers were unwilling or incapable of sharing the criteria they used with students or with colleagues. In this case, assessment still retained its old meaning as a means of 'power and control'. However, PBL demands transparency: processes of learning, facilitating and assessment need to be shared with and between students, teachers and experts.

The third mirror

The third mirror exists between product assessment and contexts (society and working life), meaning that learners are engaged in a process of relating their own actions and achievements to the requirements of working life and society. Employers are interested in the *knowing* and competence of the learner. They expect that employees are competent not only in technical skills, but also possess social and learning skills. The main question here concerns the examination system and the ability of an examination to measure exactly what is needed in working life.

The integration of product assessment within the context of working life is related to students' professional knowing and competence. Tutors clearly noted that students' professional skills started to develop during the process

of education. This was also mentioned in the feedback students received from their training periods. Tutors realised, too, that to be able to guide students effectively, the facilitators in the work place needed to know the basics of PBL. Some of the tutors argued that students were so reflective and competent that they would not be able to use their full potential when they moved into working life.

Knowing can be characterised as a process involving decision making and problem solving while accessing increasing amounts of tacit knowledge located in individual, group and cultural knowing. As with explicit knowledge, tacit knowledge is owned not only by individuals, but by communities of workers and by the whole organisation. Measuring knowing is difficult because tacit knowledge becomes visible only in fluent personal or shared actions. Therefore, it is understandable that assessment is focused on measuring the outcomes of actions. However, this kind of assessment is ineffective from the point of view of learning. Learners are left alone with their difficulties because they do not receive enough information about their knowing. Those developing education are also left without the relevant information they require.

An assessment concentrated on measuring qualifications has its own mirror *only* between the products and contexts. This results in a control system focusing on the individual qualifications of learners secured by very detailed control. Instead of this, an assessment system based on generating learning and knowing provides an opportunity for examining learning processes in the whole education system, and for justifying the pedagogical changes needed. (Poikela, E. 2004.)

The principles and criteria of assessment and evaluation have necessarily to be described in the PBL curriculum. A useful theoretical tool for developing assessment practices within the frame of PBL is described in our paper as "zones and mirrors of assessment". This enables further research and development of procedures of self-assessment, process assessment and assessment of outcomes, which benefits learners, facilitators, designers of curricula and developers of organisations.

PBL in context – bridging work and education

The aim of problem-based learning is build a bridge between working life and education. Research and evaluation is needed to examine how well this succeeds. Do PBL students gain better qualifications for working and professional life than students pursuing a so-called traditional curriculum? The next chapter, which is the second article of the book, provides one answer to this question. Researchers from the University of Linköping, Sweden compare how the students of a PBL program in Psychology and students from a conventional program in mechanical engineering manage the transition from education to working life.

The third article deals with a transition from conventional teaching to problem-based pedagogy. Using the metaphor of a journey, researchers of early childhood education at the University of Tampere, Finland analyse the obstacles, negotiations and solutions arising from a shift to a PBL curriculum. The fourth article by researchers from the University of Leicester, UK also deals with tackling obstacles encountered in using PBL, this time in the context of a Physics curriculum. PBL is applied in different ways and it is also rejected in many ways. Some of the difficulties may be self-made if the principles and criteria of evaluation are not placed at the heart of the curriculum.

The PBL curriculum offers knowledge and learning environments for students' shared and individual learning. It is also a learning environment for teachers in which they can develop their own understanding of PBL and improve their own skills in facilitating students' learning. The PBL curriculum is also a joint tool for teachers wishing to change the learning and teaching culture. If changes are made on the level of the curriculum, it is more likely that they are permanent. However, if changes are dependent on some individual teachers, they are more easily forgotten, especially if the teacher moves to a new workplace.

The fifth article describes the lessons learnt from applying PBL in Mechatronics at Lahti Polytechnic, Finland. Creating a curriculum according the principles of PBL and project-oriented learning means facing many kinds

of difficulties. The curriculum has to be understood as a tool both for teachers and students. Also, the assessment of the learning process has to be valued at least as much as the evaluation of learning outcomes which dominated the earlier curriculum. The sixth article shows how PBL is implemented in engineering education at Turku Polytechnic, Finland. The feedback questionnaire from the trial program reveals how PBL tutorials guide students' homework compared to other forms of teaching.

The seventh article is written by researchers from the National Taiwan Normal University. They offer a view of the design and construction of problems in PBL teaching. Selecting a problem, designing actions, determining learning objectives and linking contents are described as the four main phases of constructing problems. The eighth article describes the adoption of the PBL model in Medical Education at the University of Tampere, Finland. This model is based on two well-known models: the seven-jump model from the University of Maastricht, and the cyclical or scenario model from the University of Linköping. The ninth article by researchers from McMaster University, recounts how PBL is applied in Medicine and especially how students' experiences are measured.

The best way to adapt problem-based pedagogy as a teacher is to gain firsthand experience as a learner in the PBL process. This is not easy because it involves the difficult process of changing one's own identity as a teacher. The tenth article describes how teachers in Dublin, Ireland experience PBL study as demanding fun, which is essential in shaping the identity of the teacher. The last article analyses the professional development from teacher to tutor as experienced by teachers of medicine (the Faculty of Medicine at the University of Tampere) and physiotherapy (the Department of Physiotherapy Education at the Pirkanmaa Polytechnic, Tampere). Analysis is conducted within the framework of theories of learning at work.

Building a bridge between working life and education requires that teaching and facilitating are seen as activities that support teachers' own learning and professional development. PBL does not simply coach students for the future; it has already become the future for many working teachers.

References

Barrows, H. (1985) How to design a problem-based curriculum for the preclinical years. New York: Springer.

Barrows, H. (1996) Problem-based learning in medicine and beyond: a brief overview. In L. Wilkerson & W.H. Gijselaers (eds.) New directions for teaching and learning. San Francisco: Jossey-Bass, pp. 3–11.

Blackler, F. (1995) Knowledge, knowledge work and organizations, an overview and interpretation. Organization Studies 16 (6), pp. 1021–1046.

Bernstein, B. (1990) The Structuring of Pedagogic Discourse, Vol IV, Class, Codes and Control. London: Routledge.

Boud, D. (1985) Problem-based learning in perspective. In D. Boud (ed.) Problem-based learning in education for the professions. Sydney: HERDSA, pp. 13–19.

Boud, D. (1995) Ensuring that assessment contributes to learning. Proceedings. International conference on problem-based learning in higher education. University of Linköping, Sweden.

Boud, D. (2000) Sustainable assessment: rethinking assessment for the learning society. Studies in Continuing Education 22 (2), pp. 151–167.

Boud, D. & Feletti, G. (1991) The Challenge of Problem-Based Learning. London: Kogan Page.

Burnard, P. (1987) Towards an epistemological basis for experiential learning in nurse education. Journal of Advanced Nursing No 12/1987.

Chen, S.E (2000) Problem-based learning – educational tool or philosophy. In O.S. Tan, P. Little, S.Y. Hee & J. Conway (eds.) Problem-based learning: Educational innovations across disciplines. A Collection of selected papers, 2nd Asia-Pacific Conference on Problem-Based Learning. Singapore: Temasek Centre for Problem based learning 2, pp. 210–219.

Chen, S.E. (2002) Quality Assurance in PBL. Keynote paper. 4th Asia-Pacific Conference on Problem-Based Learning, 11–13 Dec 2002, Hat Yai, Thailand.

Goodson, I.F. (1989) "Chariots of Fire": etymologies, epistemologies and the emergence of curriculum. In G. Milburn, I.F. Goodson & R.J. Clark. (eds.) Re-Interpreting Curriculum Research: images and argument. London: The Althouse Press, pp. 13–25.

Cook, S.D. & Brown, S.J. (1999) Bridging Epistemologies: the Generative Dance between Organizational Knowledge and Organizational Knowing. Organization Science Vol 10, 4, pp. 381–400.

Cowdroy, R.M. (1994) Concepts, constructs and insights: the essence of problem-based learning. In S.E. Chen, R.M. Cowdroy, A.J. Kingsland & M.J. Ostwald (eds.) Reflections on Problem-Based Learning. Australian PBL Network, Sydney.

Hager, P. (1999) Know-how and Workplace Practical Judgement. In K. Forrester et al. (eds.) Researching Work and Learning. A First International Conference. University of Leeds, Conference Proceedings, pp. 645–653.

Hager, P. & Butler, J. (1994) Problem-based learning and paradigms of assessment. In S.E. Chen, R.M. Cowdroy, A.J. Kingsland & M.J. Ostwald (eds.) Reflections on problem-based learning. Australian PBL Network, Sydney.

Hannafin, M. & Land, S. (1997) The foundations and assumptions of technology-enhanced student-centered environment. Instructional Science 25, pp. 167–202.

Järvinen, A. & Poikela, E. (2001) Modelling reflective and contextual learning at work. Journal of Workplace Learning Vol 13 (7/8), pp. 282–289.

Kolb, D. (1984) Experiential Learning. Experience as the Source of Learning and Development. Englewood Cliffs, N.J.: Prentice-Hall.

Nonaka, I. & Takeuchi, H. (1995) The knowledge creating company. New York: Oxford University Press.

Pettigrew, A.M. (1985) Contextual Research: A Natural Way to Link Theory and Practice. In A. Lawler, S. Morhmam & S. Ledjord Cummins (eds.) Doing Research that is Useful for Theory and Practice. San Francisco: Jossey-Bass.

Poikela, E. (2003) Context-based assessment. Refereed proceedings of the 3rd International Conference of Researching Work and Learning 25–27 July 2003. Tampere, Finland.

Poikela, E. (2004) Developing Criteria for Knowing And Learning at Work: Towards Context-Based Assessment. Journal of Workplace Learning Vol 16, 5, pp. 267–274.

Poikela, E. & Poikela, S. (1997) Concepts of learning and the implementation of Problem-based learning. Zeitschrift für Hochschuldidaktik, Special Issue. Problem-based learning: theory, practice and research. Editors F. Eitel & W. Gijselaers. Volume 21 (1), pp. 8–22.

Poikela, E. & Poikela, S. (2001) Knowledge and Knowing in Problem-Based Learning. Refereed proceedings of 3rd Asia Pacific Conference on PBL, Experience, Empowerment and Evidence. University of Newcastle, Australia.

Poikela, S. (2003) Ongelmaperustainen pedagogiikka ja tutorin osaaminen. Tampere: Tampere University Press.

Ryle, G. (1949) The Concept of Mind. London U.K.: Hutchinson.

Zuboff, S. (1988) In the Age of the Smart Machine. New York: Basic Book Inc.