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Guest Editorial for Special Issue on Problem Based Learning and ICT

Innovation of Problem Based Learning through ICT: Linking Local and Global Experiences

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ABSTRACT

The editorial provides a background for the special issue on Problem Based Learning and ICT and focuses on three core themes: Problem Based Learning (PBL) and its background and pedagogical principles; learning characteristics of information and communication technology (ICT); and intercultural perspectives. The editorial presents a Danish perspective on PBL based on the long tradition for PBL within university teaching and learning and international collaboration. The editorial is concluded through a short presentation of the articles in this special issue.

Keywords: *Problem Based Learning; Project Based Learning; Social appropriation of technology, ICT4development*

INTRODUCTION

The idea to produce this special issue on Problem Based Learning and ICT originates from an international research seminar on Innovating Problem Based Learning through ICT at Aalborg University in Denmark, which took place in June 2006. The basis for this research seminar was a number of European projects on ICT and development in which we have been exploring how to use ICT as a means to rethink teaching and learning and to introduce forms of problem based learning (PBL) especially in developing settings. Three major European projects related to e-Learning Lab - Center for User driven Innovation and Learning at Aalborg University should be mentioned in relation to this seminar:
European and Latin American Consortium for IST Enhanced Continued Education in Environmental Management and Planning (ELAC), which is a demonstration project within the EU @LIS-programme and has eight partners from Europe and Latin America. http://www.ell.aau.dk/ELAC.59.0.html.
Mediterranean Virtual University (MVU) which is a collaborative venture between leading institutions in the Mediterranean area and the University of Strathclyde in Scotland and Aalborg University, Denmark, building a network to collaboratively develop and deliver high quality online university courses. See http://www.med-vu.org/mvu/.
Moreover the seminar was related to Kaleidoscope, a European Network of Excellence on Technology Enhanced Learning, especially the European Research Team on Conditions for productive learning in Networked Learning Environments, http://www.noe-kaleidoscope.org/pub/

The overall theme for the seminar was Employing PBL in an international context:
- Understanding intercultural conditions,
- ICT as a driver for transformation,
- Innovating PBL through ICT.

Employing PBL in an international context raises many questions. Can we adopt the methodology and apply it in another context? What are the cultural, institutional and pedagogical conditions? How to adapt PBL to the local context? How to innovate PBL through ICT? And who are the change agents – students, teachers, pedagogy designers, and managers?

In ELAC and the MVU project, ICT has been a driver and catalyst for change. ICT has not only been integrated in the existing pedagogical approach, but ICT has been used as an opportunity to rethink the pedagogical practice towards PBL-inspired approaches. The employment of ICT has taken many forms. In the projects, we have especially been focusing on ICT as a learning and communication infrastructure, which expands the learning environment beyond the physical classroom and provides flexible support for project and community work. Moreover, teachers have also started to develop rich digital materials, and especially to let the students produce digital projects.

The papers and presentations from the seminar can be found at http://www.ell.aau.dk/International-Seminar-June-200.298.0.html. Four presentations from the seminar have been further developed into peer-reviewed articles and presented in this special issue.

THE BACKGROUND OF PBL

The term Problem-Based Learning (PBL) was originally coined by Don Woods, based on his work with Chemistry students in McMaster's University in Canada. However, the popularity and subsequent worldwide spread of PBL is mostly linked to the introduction of this educational method at the Medical School of Mcmaster University in the end of 1960s (de Graaff and Kolmos, 2007).

The McMaster medical approach to PBL brought radical changes to the medical curriculum. Application in practice was seen as more important than storing facts by rote learning. This implies that learning should focus on the patient and his/her complaints. By systematically analyzing patient problems, students formulate questions with respect to the information they lack to solve a problem and to select their learning goals (de Graaff and Kolmos, 2007). This model is interdisciplinary as students integrate knowledge from different disciplines related to the same medical problem. Moreover, it trains the students to act and think like a physician. The experience of learning also becomes more exciting and more meaningful (Barrows and Tamblyn, here referred in Graff and Kolmos, 2007). The success of the McMaster medical curriculum inspired other medical schools to implement similar educational programmes in the following years, but also entire universities - for example in Denmark - were inspired by the idea of problem based learning.

The Danish tradition for PBL

In Denmark, the pedagogical approach traces back to 1970'ies when Aalborg University and Roskilde University Center were established. The universities were set up in a period of radical change. University educations were seen as a means to establish social equality. The companies asked for closer collaboration with university partners. At the same time, the student movement fought for universities as platforms for radical, social and scientific critique, and as forays for doing action research together with underprivileged groups and the working class. The pedagogical compromise, which unified these strong and partly antagonistic interests, became problem-oriented project pedagogy (POPP) (Dirckinck-Holmfeld, 2002). Theoretically, these pedagogical principles were originally inspired by the work of the sociologist Oscar Negt and his

work for the German trade unions where he formulated the principles for the educational program as the development of "Sociological imagination and exemplary learning" (Negt, 1975; 1971). In a Danish context, many scholars have been dealing with problem-based learning, but especially Knud Illeris should be mentioned as the learning theorist who has developed the theoretical basis. (Illeris, 1977; 1981; 2004) From the 70ties and to now the practical realization of POPP has taken many forms, and is based on various theoretical inspirations from critical pedagogy (Negt, Illeris, Hultengren) to more pragmatic and research-oriented approaches (Kolmos, Fink & Krogh, 2004; Adolfsen, 1985). In the later years, the approach has been expanded by inspirations from socio-cultural learning theory (especially Wenger's concept of community of practice (Lave & Wenger, 1991; Wenger 1998; Dirckinck-Holmfeld and Fibiger, 2002)

In this issue, we use PBL as a meta-concept for problem-oriented project pedagogy, problem-based learning, and project-based learning. There are nuances between the approaches, for example about who is formulating the problem to work with, as well as the balance between problem formulation and problem solving. However, often these differences are related to local conditions and not necessarily argued from a theoretical position. In the Danish tradition, PBL is a combination of problem-orientation and project-based learning. The model is integrating a number of pedagogical principles: problem – orientation, interdisciplinarity, participant control, exemplary projects, teamwork and action learning. However, the model is practised in various ways adapted to the local conditions, the subject matter, the skills of the students and supervisors, etc. (Dirckinck-Holmfeld, 2002).

Pedagogical Principles

The most important principles are *problem formulation* and *enquiry of exemplary problems* (anomalies). In other words, something, which makes the students wonder and makes them want to find an answer. The entire educational process is based upon the student's enquiry of scientific and social problems and is the focal center of the student's engagement in the learning process. In order to understand the problem and find a solution to the problem, the students have to go through different stages of systematic investigations: preliminary enquiry, problem formulation, theoretical and methodological considerations, investigations, experimentation and reflection.

According to Illeris (1981), *enquiry,* on its own, does not constitute the basis for an active process of acquiring knowledge through critical reflection: *"A problem is not a problem in a psychological sense if the person who has to work with it does not experience it as a problem."* (p. 83, our translation). Therefore, *participant control* is an interrelated principle. When students themselves define and formulate the enquiry, they have a conscious relation of ownership to it, and they experience it as a problem (anomaly), which implicitly encourages involvement and motivation. Participant control and the ownership of the problem setting are therefore seen as fundamental for the students' engagement in the learning process.

Participant control implies that the institution or the teacher cannot fully guide or control the learning process. Problem formulation is always a leap in the dark. It is the subsequent theoretical and empirical enquiry that really displays the results of the collaborative learning situation. However, supervisors can help to promote and formulate exemplary problems which can be qualified cognitive, psychodynamic, social/societal and scientific through negotiations, dialogues and enquiries about the problem area. At university level, this qualification has to be particularly focused on what is important, interesting and exemplary with respect to the subject area in a balance between historical, present and future considerations and between different theoretical and methodological positions. This enquiry and negotiation between students and teachers set the curriculum. The success of the pedagogical approach strongly depends on this

preliminary negotiation process. If too little effort is put into this phase, the students may focus on surface problems without much relevance for the subject area. Therefore, the preliminary phase of problem setting is very important and must be supported by materials, lectures, preliminary investigations and review of former work in order for students to focus on exemplary and principal problems. The PBL-approach supports the development of competencies and skills of interdisciplinary thinking and problem solving, and the competencies to identify and formulate serious problems and see problem areas in new ways.

Projects and action learning

Another central didactic principle is collaboration in *projects*. The project organization builds on a social-constructivist perspective that underlines the integration of individual construction of knowledge and the students' *mutual responsibility* for creating and conducting a joint project. According to constructivist conceptions of learning, the learner constructs knowledge by assimilating experience to prior knowledge or by accommodating existing knowledge to new experience (Furth, 1969; Piaget, 1969; Kolb, 1984). Common understandings among peer-students result from confrontations and negotiations of perspectives and beliefs. This negotiation of perspectives implies inner contradictions viewed as the prerequisite for new learning. The project moreover ensures that the learning process is not purely cognitive. In a very informal and unstructured manner, most groups use a lot of time and energy to socialize as students and to help each other in the personal search for their life trajectory. The projects are often organized as action learning, where the students work together with an organization or a company.

The collaborative learning embedded in PBL-models can be summarized as follows: Participants have a joint project and a shared enterprise, participants are inter-dependent, participants own and share the problem, participants have mutual responsibility for learning, and the collaboration among the participants is a long-term process (Dirckinck-Holmfeld, 2002)

PBL has penetrated teaching and learning systems all over the world (Savin-Baden, 2007). At the same time, the label of PBL is used to cover an amazing diversity of educational practices such as problem-solving learning, case-based learning, enquiry-based learning, problem-oriented learning, action learning. The various PBL models all share the focus on learning through investigating real world problems rather than traditional subject based teaching and student centred learning approaches.

In 2005, the UNESCO Chair in PBL in Engineering Education was based at Aalborg University. The aim of the Chair is to create a global society for researchers and academic staff working with PBL. This includes research and development activities, educational programs, consultancy activities, and the establishment of a global network for international cooperation and exchange of experiences http://www.ucpbl.net/.

ICT AND PBL

In e-Learning Lab – Centre for User-Driven Innovation, Learning and Design, Aalborg University, we are especially investigating how information and communication technologies (ICT) and digital media can enhance the PBL-approaches and -practices. PBL builds on principles of productive learning through joint project work, shared meaning construction and object orientation (see also (Dirckinck-Holmfeld, Jones, Lindström, forthcoming). ICT as infrastructure, tool and artefact plays a central role in the mediation of communication, collaboration and learning. PBL borrows ideas from production practices and is closely coupled to a tool perspective, where the tool specifically symbolizes human activity and man’s transformation of nature. The tools and access to resources

are significant to PBL. The tools are not restricted to the transformation of nature, but certainly directed towards social and mental activities as well. Following the socio-cultural approach to learning (Vygotsky, 1978), tools fundamentally mediate higher mental functioning and human actions. ICT as a tool and as a way of organising information is one of the most important societal tools of today and PBL-approaches should therefore exploit the advantages hereof.

Jones and Dirckinck-Holmfeld (forthcoming) summarise the characteristics of ICT in relation to the mediation of higher mental functioning and human actions in networked learning, which also count for PBL:

- *"Time - Computer networks affect the usual time patterns of teaching and learning. The teaching and learning environment can be organised more flexible due to the asynchronous nature of the communication technologies.*
- *Place - The introduction of mobile and ubiquitous computing devices have begun to make the idea of education and access to information taking place anytime anyplace anywhere more attainable.*
- *Digital preservation - The output of synchronous and asynchronous activity is easily preserved in transcripts, logs and a variety of other forms including the archiving of web casts and audio interviews/podcasts, which may afford reflective teaching and learning.*
- *Public/Private boundaries - The preservation of what would otherwise be ephemeral materials alters the boundaries between what is public and what is private. Tutors can now view and preserve the details of the student's interactions in group activities, making them available as tools for assessment.*
- *Forms of literacy - The still largely text based world of networked learning has generated new forms of writing that are neither simple replications of either informal conversation or of formal written texts. The use of images and audio integrated into digital environments has suggested new forms of multimedia literacy.*
- *Content – The boundary between content and process is shifting. Blogs and Wikis can provide elements of content and cut and paste re-use is common practice. The idea that there is a clear distinction between activity/process and artefact/content is becoming strained". (Jones & Dirckinck-Holmfeld, forthcoming p. xxx)*

The list indicates that PBL approaches may take many new forms due to the integration of ICT. The core principles of PBL may remain the same, however the tools to support and realize the principles have changed dramatically. The changes concern the conditions for access to information; communication and collaboration between peers – locally and internationally; knowledge acquisition and reflection; process writing and evaluation as well as production and reception of multimedia text. Especially in a developing setting, where access to resources and physical infrastructure is a big challenge, ICT can provide new opportunities to make the PBL approaches more accessible.

Intercultural perspectives, PBL & ICT

We began this article posing the question whether we just can adopt the PBL-concept, which has primarily been developed in the Western World and employ everywhere. The concept of course needs to be adjusted to the local conditions, resources and learning culture but, in principle, our answer would be *yes*. The strength of PBL is the problem-orientation and the participants' control and ownership of the problem. This gives the students and supervisors an opportunity to take point of departure in problems and ways of knowing which are relevant locally, to research and

find solutions to local problems, and contribute to theory development, where the new knowledge is included. Furthermore, the PBL approach can be used to establish connection between educational institutions, public and private organizations, civil society, etc. using the students as a kind of change agents in collaboration with stakeholders.

PBL approaches require access to resources and a shift in the teacher-student relation emphasizing student-centred approaches. The transformation towards PBL has institutional consequences. Therefore, we argue that ICT should be used as a lever for PBL. Instead of implementing ICT in the old structure, ICT should be used as a means to transform to-wards PBL, to provide a learning infrastructure and a number of resources, which makes PBL practically feasible.

ABOUT THE ARTICLES

The articles in this volume all contribute to the exploration of how ICT can support PBL-approaches in new ways, and the conditions for employing PBL in an international context. A special interest concerns the intercultural conditions such as pedagogical traditions, human resources, competence building, social and cultural issues.

The article “Multicultural and Creative On-Line Learning” by Veronica Córdova S. from Universidad Católica Boliviana, Bolivia and Katherine Goodnow from University of Bergen, Norway is especially concerned with the design of infrastructures for learning in an intercultural environment. The authors are concerned with the use of a text-based environment – a Moo – to run theoretical and creative courses in the area of media studies. In the article, the authors consider three on-line learning projects: A Masters in Screenwriting run by the University of Bergen and the International Film School in Cuba (EICTV); an on-line screenwriting workshop organized by La Fábrica Film School in Bolivia; and a collaborative project on virtual exhibitions organized by the Corporación de Tecnologías Digitales in Ecuador and the Department of Information Science and Media Studies at the University of Bergen. All three projects involves creative and theoretical work within the broad area of media studies. Two of the courses are multicultural and multinational while one is mono-cultural. All three projects utilize a cmcMoo environment created at the University of Bergen in 1999. This free text-based environment allows problem-based collaborative learning and community building across institutions with differing technologies and bandwidth scenarios.

To analyze the case studies, the authors identify three core issues that shapes the understanding of problem based learning organized as networked learning in multicultural environments. These core issues are: Offline and online contexts; the place of gender and cultural background; and conceptions of community and community building. These three core-issues are obviously inter-related but they give some keys to begin to understand the variables affecting the running of the program and the relationships that emerge. One general conclusion, which the authors identified, is that it is important to look for the nuances surrounding the concept of “development”. Not all the difficulties commonly perceived as being related to working in a “developing” country can be tied to the South country. In the first case, many of the detrimental issues related to “development” could be tied to attitudes and expectations in the North. Moreover, it is important to differentiate between issues related to multicultural programs and those related to “development”. The mono-cultural program from a similar socio-cultural and language background was the most successful despite it being run within a very poorly resourced country. This does not mean that few resources do not restrict a program but that it is important to look beyond technological constraints to find the difficulties as well as the potentials in multicultural programs. The learning process of moving beyond national and cultural borders does, however, in the end compensate for the difficulties encountered – for both staff and students.

The article “Managing the Gap between Curriculum Based and Problem Based Learning: Deployment of Multiple Learning strategies in Design and Delivery of Online Courses in Computer Science” by Ann Bygholm and Lillian Buus from Aalborg University, Denmark addresses the theme transformation of teaching and learning through PBL. The paper takes its point of departure in the Mediterranean Virtual University project (henceforth MVU) which was a collaborative venture between institutions in the Mediterranean region: University of Cyprus, Ains Shams University, Egypt, Jordan University of Science and Technology, University of Malta, Islamic University of Gaza, Birzeit University, Palestine, Welfare Association, Palestine), Sabanci University (Turkey), American University of Beirut (Lebanon) the University of Strathclyde in Scotland and Aalborg University in Denmark building a network to collaboratively develop and deliver online courses within the domain of computer science, which could meet the requirements of industry and individuals. Furthermore, the project aimed to explore opportunities and advantages afforded by e-learning, and to build capacity among the participating partners in ways that could be cascaded locally and sustained. The project, which was funded by the EU EUMEDIS[1], had a duration of two years (2004-2006). The project resulted in the development of 40 undergraduate level courses in computer science. The role of Aalborg University was to train participants in learning design and to specify pedagogical models for effective delivery of online courses. The training was delivered by two sets of activities, one for course developers and subject specialists providing them with knowledge on pedagogy and e-learning and another for tutors providing them with knowledge and experience in online teaching strategies.

The paper problematizes the distinction between curriculum based and problem-based approaches to accomplish learning. Preferred approaches depend of conviction, culture, traditions and also on the specific learning situation. The authors argue that it is not a question of either/or but rather both/and. They describe an approach to design and delivery of online courses in computer science, which, on the one hand, is based on a specified curriculum and, on the other hand, gives room for different learning strategies; problem based learning being one of them. The paper presents a pedagogical framework embracing both problem-based and curriculum strategies and discusses the challenges in applying problem based learning strategies in a context where several universities, with different cultures of teaching, collaboratively develop and deliver online courses. One of the findings in the paper is that the PBL-model has functioned as a vehicle for raising awareness on activity based learning and although the model was considered as too radical, it fostered many discussions on possible pedagogical strategies.

The article “The Student as Producer of Digital Materials in Hybrid Courses” by José Luis Rodríguez Illera and Anna Escofet Roig, University of Barcelona, Spain deals with pedagogical design. The paper addresses how ICT-mediated teaching and learning can place the student at center stage – in a role where he or she is called on to play a creative role. Within this framework, the authors devise a teaching experiment for undergraduates studying Pedagogy, Audiovisual Communications and Library Sciences. The experiments are centered on the undertaking of project work that is designed specifically for the students and with the aim of allowing them to develop their skills as learners. The projects have one main characteristic: their practical nature. From the outset, the students are instructed to be the creators and producers of digital materials. The digital materials designed by the students fall into three categories: electronic books, digital stories and webquest.

The educational experiment is situated in a theoretical discussion of learning approaches. Based on the findings from the experiment, which has produced clearly positive results, the authors argue that putting students in a position where they have to produce knowledge, demonstrate the skills they have learnt, and work, in short, on an integrated project (in which the technologies and

contents are closely intertwined) is a pedagogical conception that is interesting for the methodological change, and one that is relatively unusual in the social sciences and humanities.

The article “Tele-collaborative Projects in Brazilian Schools” by Miriam Godoy Penteado, State University of São Paulo, Brazil focuses on the implementation of project work in public secondary schools in Sáo Paulo State in Brazil. A main idea of project work is to make students the centre of their learning processes. Furthermore, problem-oriented project work opens possibilities for students to act in an investigative way. The centre of attention in the article is on the use of the Internet to support communication and collaboration (tele-collaboration) among students working with a project in mathematics. Tele-collaborative projects are a way of integrating students of different schools in a virtual environment in order for them to collaborate on the topics they are developing. The Internet makes it possible for students from different schools, different cities, and even different countries to work together. The project involves schools from the same city where the university is located as well as from other cities.

The interest is to explore the possibilities and limitations within public schools for a PBL-educational approach aiming at teacher education for the use of technology. The schools do not have many computers available for educational use. There are even schools which have no access to Internet. In order to exploit the power of problem-oriented project work and use of technology, it is necessary to consider its implementation in the school environment. The article provides many valuable considerations in relation to the implementation of PBL in mathematics and demonstrates that the integration of PBL, ICT and mathematics can widen the scope of mathematics, make mathematics relevant in the life of the students, and also make the students’ project work important to the public. What was produced in the virtual classroom did not stay only in the teacher’s hands. It became public for an audience outside their own school and at the same time introduced the kids to the university.

CONCLUSION

The articles all together demonstrate that there is not only one way of doing PBL, but PBL has to be adjusted to the local conditions, as well as the educational and cultural traditions. Access to ICT is in many “developing” contexts more limited, however the students and staff are very motivated to engage with ICT as a means to search for information, and for (tele) communication and collaboration. This does not mean that poor resources do not restrict a program, but it is important to look beyond technological constraints and to use the human resources in the educational organizations as point of departure for the integration of ICT and to use it as an opportunity to reform the educational approaches.

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