DPBL: HELPING GLOBALLY DISTRIBUTED TEAMS LEARN USING ICT

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In recent years research into different aspects related to implementing PBL programmes in networked environments has gained impetus (Orrill, 200; Ronteltap & Eurelings, 2002). Some have seen Distributed Problem-based Learning (dPBL) – PBL in a networked setting – as a good answer to address the perennial problem PBL practitioners have with limited resources (Steinkuehler et al., 2002), while others have investigated the actual activities that students engage in while working as a team in such environments (McConnell, 2002). This paper describes an 18 month project in which a purpose-built portal was created to support a PBL programme shared between UK and Singapore students. It discusses the preliminary results gleaned from the quantitative and qualitative data. This project was funded by the British Council (Singapore).

INTRODUCTION

PBL was first introduced into the medical curriculum at McMaster University, Canada in the 1960s. Maastricht University adopted PBL in their medical programme in 1976 and established the seven step problem-solving cycle; and in the early 1980s, Barrows and Tamblyn (1980) published their work conducted at the Southern Illinois School of Medicine. In the 1990s, Woods (1995) published extensive work on PBL in chemical engineering courses at McMaster University, focusing in particular on process skills workshops that teach students skills in group learning, stress and time management, among other core skills identified as desirable life skills for undergraduates.

Although there have been different models of PBL in practice in different learning situations, leading to discussions about what is authentic PBL and what is not, some basic characteristics of PBL prevail. In all PBL environments, students are presented with real-world problems and "acquire knowledge and skills through staged sequences of problems presented in context, together with associated learning materials and support from teachers" (Boud *et al.,* 1997, p.2).

There are different models of PBL in practice, ranging from those with no specific tutor predefined learning outcomes (McConnell, 2002, p.59) to those with structured sequences and clearly defined goals for each stage (Steinkuehler et al, 2002, p. 26). The Temasek IT School adopts a model pitched somewhere in the middle of this continuum and takes into consideration the learner characteristics, faculty expectations and institutional requirements; the rationale for establishing this model is beyond the scope of this paper and has been presented elsewhere (Chew, 2000).

In this project, students' acquisition of two key component skills was emphasized, namely enquiry skills and collaborative learning skills. The former refers to skills such as questioning skills, and the latter refers to group learning and team skills such as conflict resolution and negotiation skills. A third important skill was the ability to use ICT tools effectively in a virtual learning environment to foster group learning; and this is what the present paper will focus on in the next section.

Computer-Supported Collaborative Learning (CSCL) and Distributed Problem-based Learning (dPBL)

The main driving force of the PBL process is the problem, but the mechanism that sustains the learning process is collaborative learning. This is in line with three primary constructivist principles identified by Savery and Duffy (1995, p.31):

- understanding comes from our interactions with our environment, in this case, the virtual learning environment (VLE).
- cognitive conflict stimulates learning.
- knowledge evolves through social negotiation and evaluation of individual understanding.

Throughout the PBL process in this study, students were expected, perhaps even forced by the learning environment, to collaborate with one another. Collaborative learning is not "divide and conquer", but as Dillenbourg et al. (1996, cited in Fåhrærus, 2003, p.1) put it, it requires collaborators to engage in "cognitive processes that may be (heterarchically) divided into intertwined layers".

For collaboration to be successful, two conditions must be present

- there must a shared goal, and this is negotiated by all the members in the group.
- individuals must be motivated to work for the group. This requires the learning environment to be one that the participants feel they trust and belong to.

Lave and Wenger (1991, p.29) uses the phrase "legitimate peripheral participation" to describe newcomers to a group who are required to master knowledge and skills specific to the context of this group in order to move from the peripheral participation toward "full participation in the socio-cultural practices of a community". In other words, the participants develop their identities within the group. This is what pushes the participants to work for the group and engage in quality collaboration, not the rules set by the tutors, or the threat of punishment (in terms of poorer or failing grades) or even group sanctions. McConnell (2002, p.72), studied a group of educational practitioners in a dPBL environment. He reported that intrinsic sources were the driving force behind the work of the teams, encouraging the subjects to develop and see themselves as a learning community.

In summary, the PBL framework of the programme described in this study required the subjects to collaborate in problem-solving by discovering knowledge, both technical and about learning, as a team in a virtual learning environment (VLE). The VLE in this case was a purpose-built, web-based portal.

THE DESIGN OF THE PROGRAMME

The problem in this study was based on a scenario in which a group of technical specialists were required to secure electronic transactions over the company network, and protect this and all other data from being obtained by hackers. The UK and Singapore groups were expected to collaborate over the INT-SCL Portal (a student-centred learning portal created by the School of IT at Temasek Polytechnic), and create mirror systems that would accomplish this task. Each team was given 5 personal computers and associated software/hardware. As part of the IT PBL programme design, the entire PBL process was scaffolded into three key stages, with specific deliverables. These include two learning templates (where the members documented their findings on pre-designed templates), a topology diagram showing the network, and a presentation cum laboratory demonstration exhibiting their implementation. Other deliverables included a Peer Assessment (PA) and a Self Assessment (SA). All deliverables carried a certain portion of the marks, except for the SA. The whole programme ran over 6 weeks, including a week of student induction. For post-implementation, an ISDN video conference (VC) was conducted to help students reflect on the learning process as a team, a questionnaire was administered, and interviews were conducted with every student based on information gleaned from an analysis of the questionnaire findings.

The students were required to engage in both group and individual work, and collaborative work was always preceded by a period of self-directed, individual learning.

The entire problem package was reviewed by the UK tutors in two face-to-face meetings and by e-mail, and a final package was prepared. The whole process took 4 months. This process was necessary, as careful planning of a PBL course is a critical factor in determining how successful the programme will be, and this is even more true for a dPBL course. The selection of tutors is also important, as many "PBLers", especially novices, will testify that the facilitation skills of the tutors determine the quality of the programme. Although this is generally true for any learning programme, it is more so for PBL, as the learning process rests entirely on students' modeling their tutors in the inquiry process during the discussions, at

least in the initial stage. The programme is liable to collapse if somehow this modeling stage is not accomplished.

In online education, the facilitators' skills or lack of them in creating a trusted and comfortable online environment will make or break the programme. Building a learning community does not just mean providing the infra-structure for the community, it requires careful orchestration of activities, both academic and social. Preece *et al.,* (1994, p. 161-162) describes how different technologies helped users in creating a "common ground" which is an important stage in building an online community. The work of other researchers in this area gave the researchers in the present study an idea of how the different communication media could be used in the study by the participants to co-construct an effective online community.

THE RESEARCH DESIGN

The research project focused on staff and students' use of electronic collaborative tools in a PBL setting. Lecturers and students from Temasek Polytechnic and Edge Hill College of Higher Education in the United Kingdom participated in the project. A total of 16 students were chosen for this pilot study, eight each from Temasek and Edge Hill. The students from Temasek IT School were on average 17-18 year olds in their second year pursuing a diploma in Internet Computing, and had some experience with PBL programmes.

In the first cycle, the students from Edge Hill were on average 22-40 year olds in their third year pursuing a degree in Information Systems, and were mostly working adults returning to do a degree. They had also had some experience with PBL in the previous year under one of the tutors. All the students were selected on a voluntary basis, and their academic performance was considered average among their peers.

In this study, the main focus was on how ICT, and specifically how the tools available on the Portal, helped participants in their collaborative work in a dPBL environment. We wanted to investigate how the participants mediated their learning through the use of the tools present in the environment. The research questions were:

1. What influences the participants' choice of communication tools in accomplishing the stages of the PBL cycle?
2. How do participants use the different communication tools to achieve collaboration with other members of the PBL team?

The students had full control over their choice of tools except for the ISDN conferences, the frequency of use being constrained by budget. The project comprises two action research cycles: First Cycle (Sep-Oct 2002) and Second Cycle (Sep-Oct 2003).

The results from the first cycle were used to inform the design of the second cycle, in which another team of students worked on a very similar PBL case using the same VLE. The tools and methods of analysis were also refined for use in the second cycle. Due to limitation of space, this paper will focus only on the first cycle.

A naturalistic inquiry approach was adopted in this study as it was considered the most suitable in helping us understand the processes from the participants' viewpoint (Koschmann, 1996). Both quantitative and qualitative data were collected and analysed. The former were collected by means of a questionnaire, and the results gleaned informed the design of the interview questions used in the qualitative portion of the study. The qualitative data was collected via an analysis of the synchronous and asynchronous discussions such as chats, forums and video conferences, as well as through interviews with the subjects. In this paper, only the quantitative results will be presented due to space constraints.

RESULTS AND DISCUSSION

Tables 1 shows the raw scores obtained via the questionnaire. The same results are presented in the form of line graphs in Figures 1 and 2. These results show the students' perception of the degree of effectiveness of the different communication media afforded by the VLE and other technologies, compared across the nine PBL stages. All 16 subjects participated in the survey. The vertical axis is a simple summation of the responses, with a possible maximum score of 75.

	NETMEETING				**PORTAL**				
PBL Stage	**ISDN Video Conferencing**	**Synchro-nous Chat**	**Audio**	**Video**	**Drop Box**	**Forum**	**Peer-Assessment**	**Self - Assessment**	**Face to Face**
Clarification & understanding problem	10	61	41	30	53	57	14	10	49
Identification and prioritisation of learning issues	15	62	36	29	57	58	14	9	48
Distribution of learning issues for research & learning	12	59	33	29	60	62	15	3	46
Learning & research	14	47	27	22	57	58	15	6	44
Sharing of learning	23	55	33	25	66	63	17	5	47
Application of learning – solving the problem	15	52	36	28	56	59	14	4	46
Reflection	41	29	22	23	30	35	36	20	28
Team maintenance / social	50	58	51	49	28	55	33	10	46
Peer assessment	25	30	26	26	29	32	45	28	27
Total	205	453	305	261	436	479	203	95	381

Table 1: Raw Scores of the Survey on the Effectiveness of the Communication Media

The face-to-face meetings took place only between members from the same country and rated highly in terms of effectiveness. Where this option was not possible, the other media such as the synchronous chats, Drop Box and Forum were also rated favourably.

On a highest possible score of seventy five, the synchronous chat, portal forum and Digital Drop Box were rated as being highly effective for clarifying and understanding the problem statement and identification and prioritization of learning issues, with the chat scoring slightly higher than the portal forum and Digital Drop Box.

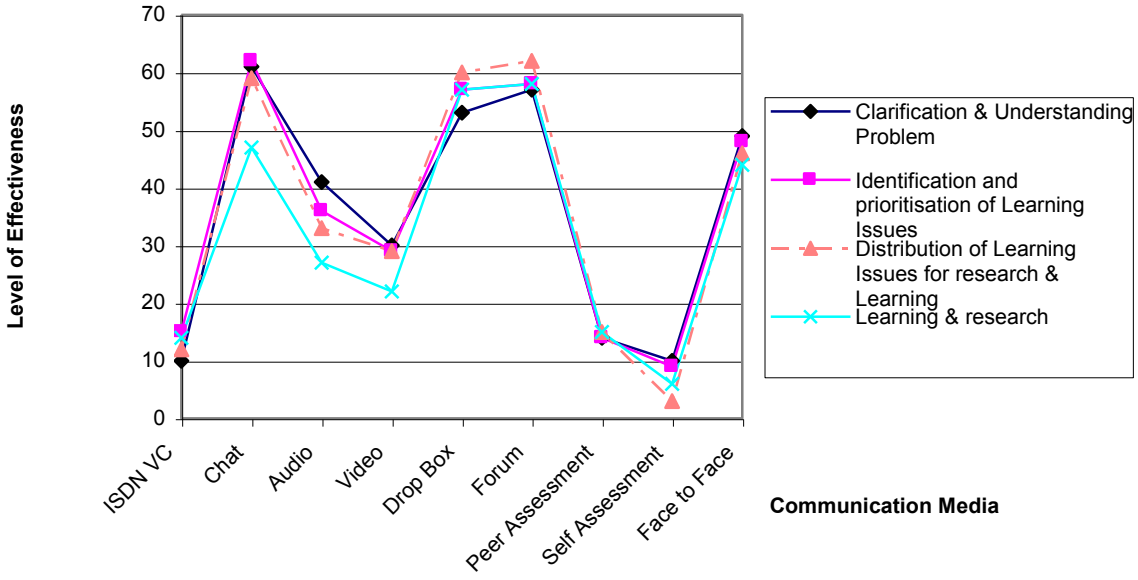

Fig 1 Level of Effectiveness of Communication Media Compared Across PBL Stages

The asynchronous features of the programme allowed the students to be more flexible in terms of their schedule, particularly having extra time to read and reflect on previous postings before making their own contributions, so it is not surprising that in terms of distribution of learning issues for research and learning by team members, students rated the portal forum and Drop Box higher than the synchronous chat.

One important aspect to be pointed out is that the sub-teams from UK and Singapore read each other's postings and held face-to-face meetings *before* posting their contributions, thus effectively reducing the online contributions to 2 sets instead of 8. This is important, since one common problem with asynchronous learning networks is that where the group number is too large, there is a tendency for information overload. Sometimes the messages are even repetitive or irrelevant, causing much frustration. Also, in some instances, it has been observed that where some members make multiple contributions almost every day, the other members are likely to be discouraged from contributing, since everything that needed to be said has already been said; thus giving the impression that some contribute a lot more than others, unconsciously creating an environment of anxiety and competition.

Palloff and Pratt (2001, p.50) talk about "addiction" where a participant spends a lot of time online, constantly posting (unfortunately not necessarily reading postings, though) and requiring others to do the same; when this does not happen, such a participant resorts to sending inflammatory messages. In the researchers' own experiences with Computer-

Mediated Communication (CMC) courses, some participants send frequent one-line contributions or messages of incredible length, causing students to lose interest both in keeping up with the volume and in the task itself.

Indeed, Palloff & Pratt observed "a typical reaction to overload is to retreat". In this study, the module developers allowed participants the freedom to decide the mode and number of participants (whether intra-group or inter-group) involved in each discussion, assured in the fact that the environment of trust and goodwill that they created with the help of the participants would encourage all to participate actively in the programme. This was exactly what the students reported in the interviews – that the participants made great effort to engage in the tasks. They were also conscious of the fact that they were taking up the precious time and space of other participants, so they researched their issues thoroughly before posting anything on the forum.

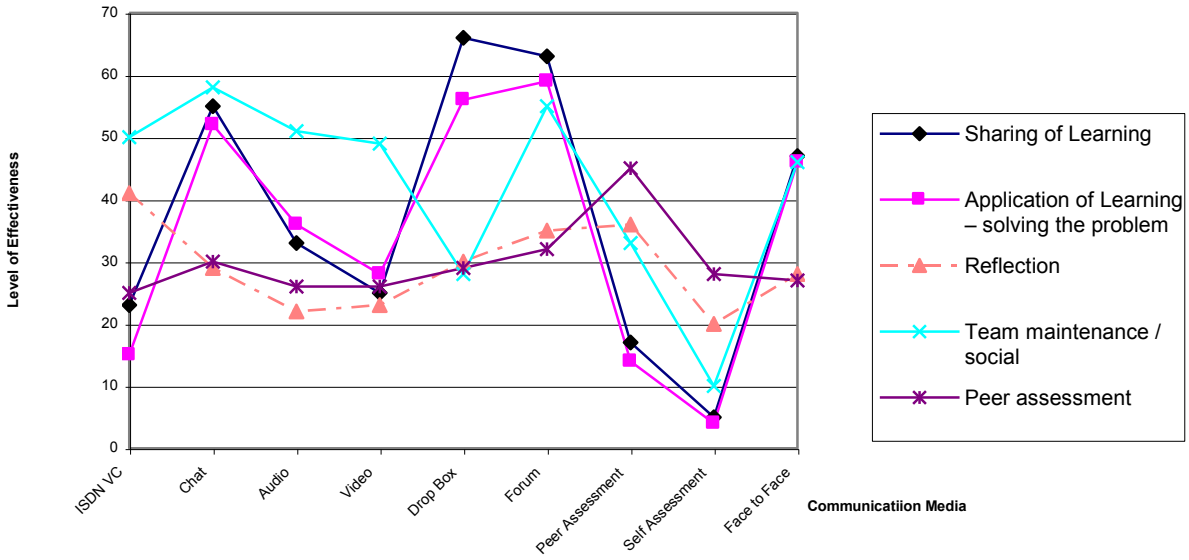

Fig 2 Level of Effeciveness of Communication Media Compared Across PBL Stages (continued)

The results in Figure 2 show that in terms of "Sharing of learning and application of learning", the asynchronous modes (namely the portal forum and Drop Box) were considered most effective. The Forum was used mainly to

- inform members about what they had deposited in the Drop Box
- clarify issues raised by others
- give additional information or comments about postings

This is the most important stage in collaborative learning, where students build on each other's contributions as much as they are contributing new material. In this study, the feedback given to students by their peers helped affirm their identities in this small online community.

The Drop Box was designed to accommodate files of any type and size. The tutors were given the option to deposit exemplary work in the "Public" boxes (target audience would be the experimental and control groups) or the "Inter-group" boxes (selected groups). Otherwise the work posted was only visible to members of the same team, a trusted environment that ensured the comfort of the contributors.

In terms of "reflection", students rated ISDN video-conferencing (41), the peer assessment instrument (36) and the forum (35) as the media that had encouraged them to do self-reflection. The ISDN conference held at the end of the module was designed to elicit student's perceptions regarding three main areas:

- ***Team strategies***
  How did you work as a team?
  What helped you?
  How did you resolve your differences?

- ***Metacognitive processes (individual and team)***
  Did you or your team have a strategy when tackling the problem?
  Did this strategy change? Did you revise it?

- ***Technical features***
  How did the tools in the VLE help you?
  What improvements would you like to see?

These results helped sharpen the focus of the research. At the next level of analysis, the question of how exactly the participants used these media in their collaboration to accomplish their tasks was examined. At this level, the researchers used the Grounded Theory and Activity Theory (Russell, 2002) to analyse the qualitative data; these results will be published at a later date.

CONCLUSION

The advantage of having a wide array of communication tools became clear in this study, particularly given the global distribution of the teams. The rich set of ICT tools afforded the students a good selection of mediation tools from which they can make the most suitable choices for their contexts. For example, where they had to make decisions about administrative tasks such as fixing a time for a net meeting or deadlines for deliverables, real time meetings (synchronous chats and face to face meetings) were found to be most effective.

On the other hand, the time difference of seven to eight hours (summer/winter time) made it necessary for students to make use of the asynchronous tools on the portal. These were mainly used for complementary tasks, such as exchange of information and product delivery (Dropbox) and challenging contributions and constructing shared understanding (forum).

In this study, the VLE housed a number of useful mediation tools for the use of the participants. They were able to make appropriate choices of tools for the different PBL stages

identified by the curriculum developer, and use them successfully to create high-performing virtual teams.

The analysis of semantic discussion threads using the Grounded Theory (Strauss and Corbin, 1998) revealed that all of the ICT tools were used effectively by the students to complete the tasks associated with each PBL stage. This emphasizes the need for an integrated set of such tools to encourage the development of high-performing teams.

All the teams involved in this study produced high-quality solutions to the problem with significant input from both the UK and the Singapore parts of a team. Due to the design of the programme, at no time did any sub-team withdraw from the international teams to produce their own solution. They successfully demonstrated interdependence and co-construction of knowledge.

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