TOWARD A LEARNING ORGANIZATION MODEL FOR STUDENT EMPOWERMENT: A TEACHER-DESIGNER'S EXPERIENCE AS A COACH BY THE SIDE

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ABSTRACT

This paper investigates a learner-centered model for student empowerment from the perspective of collaborative learning. Specifically, our discussion renders the idea of a learning organization in the development of such a model targeted for a class of students, led by the teacher-designer, to be transformed into a community of learners. The paper discusses the new roles of the students as well as the teacher, to be collaborators and active participants in the renewed educational process. We also describe our current experiences in classroom organization and course management in terms of such components as the pedagogy, which has been selected as problem-based learning (PBL) for its operational richness and practicality for group-based project work among students in preparation for their later professional careers, and the curriculum under experimentation, which is a junior core course in our undergraduate degree program in Software Engineering, for its flexibility to fit our course delivery into a collaborative learning environment. Essentially, this paper serves as an expression of our ongoing action research to document the efforts in blending the constructivist theory of learning with the technical reality of university education to equip students in the real-world profession of their own choice, through transforming the teacher as the coach by the side, instead of the sage on the stage, presumed with the power of knowledge transmission.

KEYWORDS

Collaborative learning, constructivism, learning organization, problem-based learning, student empowerment, community of learners

1. INTRODUCTION

It is experienced that the conventional approach to education remains the instructivist one, in which knowledge is perceived to flow from experts to novices (Booth, 2001). This transmissive view of learning is most evident in the emphasis on lectures, in the use of textbooks to prescribe reading, and in the nature of tutorials and assessment methods. It assumes that the process of good teaching is one of simplification of the truth in order to reduce student confusion. Yet, this simplification could deny students the opportunity to apply their learning to dynamic situations. We often question the transferability of the instructivist learning and ask how much of that which is assigned to academic learning ever gets applied to actual scenarios (Salomon and Perkins, 1989), when there is such a rapid surge in knowledge commonly associated with the birth of the Information Age. This is a transference problem. Actually, the content product of learning is assuming a less important role relative to the process of learning as the life of information content shortens and the need for continual learning increases. Relatively recent discussions in the literature (Cobb and Yacket, 1996; Marshall, 1996; O' Connor, 1998; Vygotsky, 1978) suggest that learning is increasingly viewed as a constructive process occurring during one's participation in and contribution to the practices of the community of learners. This is supported by a current shift (Brown, Ash, Rutherford, et al., 1993) from the cognitive focus on knowledge structures presumed in the mind of the individual learner, to a constructivist focus on the learner as an active participant in a social context. Indeed, we have been witnessing classroom culture being shifted away from the obsession with knowledge reproduction, and enriched with tools such as the Web-based search engines that mediate knowledge building and social

exchanges among peers as participants in discourse communities (Bonk, Medury and Reynolds, 1994; Bonk and Reynolds, 1997; Fabos and Young, 1999). These communities open opportunities for learners to interact with multiple perspectives, which challenge their existing knowledge constructions and impose cognitive conflicts (Piaget, 1952) requiring negotiations. Our literature review also indicates that problem-based learning (PBL), considered as an instance of the constructivist pedagogy, represents a promising relief from the instructivist tradition. Greening (1998) describes it as a vehicle for encouraging student ownership of the learning environment. There is an emphasis on contextualization of the learning scenario, providing a basis for later transference, and learning is accomplished by reflection as an important meta-cognitive exercise. Besides, the execution of PBL, often done via group-based project work, reflects the constructivist focus on the value of negotiated meaning. More importantly, PBL being not confined by discipline boundaries encourages an integrative approach to learning, which is based on requirements of the problem as perceived by the learners themselves. In this regard, this paper expounds a learner-centered perspective of PBL based on the idea of collaborative learning, where we should first review the basics of PBL, then discuss the necessary conditions for effective PBL, third presents our design of a collaborative learning environment in support of PBL, in terms of the new roles for the teacher and the student, plus some reflective feedback on classroom organization and course delivery. Moreover, we shall situate our discussion of PBL-based collaborative learning in an organizational setting of self-directed work teams, so as to bring forth the implication of the learning organization model of student empowerment.

2. THE PBL PARADIGM OF INVESTIGATION

The modern history of PBL began in the early 1970s at the medical school at McMaster University in Canada, and ever since, PBL has been adopted in various fields such as Teaching, Engineering and Management. Pedagogically, the PBL approach uses real-world problems (Greening, 2000; Ryan, 1993) to drive the learning rather than mere lectures with the instillation of subject matter. It acknowledges the possibility of prior knowledge held by the learner. Further knowledge is acquired on a 'need to know' basis, enabling the learner to diagnose one's own learning needs. Knowledge gained is fed back into the problem in an iterative loop, allowing the synthesis of topics and know-how. When applied to the course setting (Barrows, 1986; Bruer, 1993), PBL helps develop in students, self-directed learning and problem-solving skills, while they interact, discuss and share relevant knowledge and experience. It is designed to actively engage students, divided in groups, in opportunities for knowledge seeking, for problem solving, and for the collaborating necessary for effective practice. At the heart of PBL is a set of group-based activities, including climate setting, starting a problem, following up the problem, and reflecting on the problem (Barrows, 1985, 1988; Savery and Duffy, 1995). A brief description of the PBL model of investigation could be presented below.

- *The Climate Setting Phase*

At the outset, before the PBL group work begins, students must get to know one another, establish ground rules, and help create a comfortable climate for collaborative learning. Meeting in a small group for the first time, students typically introduce themselves, stressing their academic backgrounds to allow facilitators and each other to understand what expertise might potentially be distributed in the group. The most important task is to establish a non-judgmental climate in which students recognize and articulate what they know and what they do not know.

- *The Problem Initiation Phase*

The actual PBL episode begins by presenting a group of students with minimal information about a particular problem. The students then query the given materials to determine what information is available and what they still need to know and to formulate an action plan to tackle the problem. During this phase, students typically take on specific roles. An example is the scribe, who records the group's problem solving, including listing the facts known about the problem, students' ideas, additional questions about the problem, and the learning issues generated throughout ensuing discussion. Such written record helps the students keep track of their problem solving and provides a focus for negotiation and reflection. Throughout the problem-solving process, students are encouraged to pause to reflect on the data collected, generating additional questions

about that data, and hypothesizing about the problem and about possible solutions. Early in the PBL process, the facilitator (instructor) may question students to help them realize what they do not understand. As students become more experienced with the PBL method and take on more of the responsibility for identifying learning issues, the facilitator is able to fade this type of support, or scaffolding. After the group has developed its initial understanding of the problem, the students divide up and independently research the learning issues they have identified. The learning issues define the group's learning goals and help group-members work toward a set of shared objectives. These objectives can also help the facilitator to monitor the group's progress and to remind members when they are getting off course, or alternately, to ask if they need to revise their goals.

- *The Problem Follow-up Phase*

In this follow-up phase, students re-convene to share what they have learned, to re-consider their hypotheses (learning issues) or to generate new hypotheses in light of their new learning. These further analyses, and accompanying ideas about solutions, allow students to apply their newly acquired knowledge to the problem. Students share what they have learned with the group as they interpret the problem through the lens of their newly accessed information. At this point, it is important for the students to evaluate their own information and that of the others in their group. In the PBL group, information is not often accepted at face value. Students must discuss how they acquired their information and critique their resources. This synthesis process is an important means of helping the students become self-directed learners. In the process, they are constructing knowledge by anchoring their new findings on their existing knowledge base.

- *The Problem Reflection Phase*

During this post-problem reflection phase, students deliberately review their problem-solving process through conducting a self- or peer-evaluation to abstract the lessons learned. They consider the connections between the current problem and previous problems, considering how this problem is similar to and different from other problems. This reflection allows them to make generalizations and to understand when this knowledge can be applied (Salomon and Perkins, 1989). Finally, as the students evaluate their own performance and that of their peers, they reflect on the effectiveness of their self-directed learning and their collaborative problem solving.

Essentially, the PBL paradigm revolves around a focal problem, group work, feedback, class discussion, skill development and ongoing reporting. The instructor's role is to organize and pilot this cycle of activity, guiding, probing and supporting students' initiatives along the way so as to empower them to be active, autonomous, and self-responsible in their own learning.

3. THE DESIGN OF PBL-BASED COLLABORATION

According to Johnson and Johnson (1989), if collaborative learning is to succeed, as in the PBL case, we need to be mindful of nurturing some basic conditions among the students' community. Examples include the following: Students must see themselves as positively interdependent so that they take a personal responsibility for working to achieve group goals; they must engage in considerable face-to-face interaction in which they help each other, share resources, give constructive feedback to one another, and keep an open mind; and they need be trained to perfect their group process skills. All these imply some renewed mindset for the roles of being the teacher and the student, as well as a renewed perspective of the pedagogical organization. We are going to examine each of these in the following discussion, putting forth the new implications above the conventional wisdom of teaching and learning in school.

3.1 A New Role of the Teacher

Instead of performing as the sage on the stage transmitting knowledge to a class of innocent students, in the collaborative learning environment, teachers' roles are often defined in terms of mediating learning through dialogue and collaboration where knowledge is created in the community rather than being transferred from the individual. More specifically, the idea of mediating could include such aspects of facilitating, modeling,

and coaching (Chung, 1991; Mayer, 1988; Whipple, 1987). Facilitating involves creating rich activities for linking new information to prior knowledge, providing opportunities for cooperative work and collective problem solving, and offering students a multiplicity of authentic learning tasks. Modeling serves to share with students not only the perceived content to be learned, but also the important meta-cognitive skills of higher-order thinking, in the process of communication and collaboration. Coaching involves giving hints or cues, providing feedback, redirecting students' efforts, and helping them use a strategy. A major principle of coaching is to provide help only when students need it so that students retain as much responsibility as possible for their own learning. In fact, we need to teach students to rely less on teachers as the source of knowledge. We need to help them learn to learn as self-directed groups of active, autonomous, and responsible individuals. One of the specific goals in the PBL setting is to have students rely more heavily upon their classmates for assistance in doing a task and in evaluating a possible solution. Only after they have checked with everyone in the group should they ask their teacher for help. Operationally, it is the teacher's job to specify the instructional objectives, usually in discussion with the learning (PBL) groups; explain the cooperative goal structure; observe students' interactions in terms of the learning process, and social relationships within the group; feedback on the group-based evaluation of the learning products; and also maximize social interaction among groups through suitable design of inter-group interacting patterns, to create the expected community of learners among the students in the class.

3.2 A New Role of the Student

In collaborative learning settings, students are expected to assume their new roles as collaborators and active participants. It may be useful to think how these new roles influence processes and activities before, during, and after learning. For example, before learning, students set goals and plan learning tasks. During learning, they work together to accomplish tasks and monitor their progress. And, after learning, they assess their performance and plan for future learning. In practice, students constantly need help from the teachers to help them fulfill such new roles. Specifically, students need to learn to share, rather than compete for, recognition, and evaluate the learning outcomes rather than hurry to finish the task. It is important to nurture a group-based atmosphere for comfortable trial and error as well as for asking questions and expressing opinions. Students must learn to become teachers of their own, and the group-based interaction should serve as the incubator for co-development of ideas. Indeed, a frequent formula (Dilworth, 1998) that action learning proposes has been quite useful in constantly reminding students of their new role in collaborative learning. Namely, L = P + Q + R, where L (learning) equals P (programmed instruction) plus Q (questioning) plus R (reflection). Here P represents the knowledge coming through textbooks, lectures, case studies, computer-based instructions, and many others. This is an important source of learning but carries with it an embedded caution flag. That is, P is all based in the past. Q means continuously seeking fresh insight into what is not yet known. This Q helps avoid the pitfall of imperfectly constructed past knowledge. By going through the Q step first, we are able to determine whether the information available is relevant and adequate to our needs. It will point to areas that will require the creation of new P. R simply means rethinking, taking apart, putting together, making sense of facts, and attempting to understand the problem. Following the use of this formula, action steps are planned and carried out with constant feedback and reflection as the learning takes place. In short, what this formula can provide for PBL students is elevated levels of discernment and understanding through the interweaving of action and reflection.

3.3 A Renewed Pedagogical Organization

It is understood that collaborative learning will not take place with students sitting in rows facing the teacher. At least, tables or desks must be pushed together in small groups to facilitate group interaction. Materials and resources should best be made readily accessible. Indeed, the basic requirements for PBL group-based activities are often beyond the capacities of many a classroom in our university environment today. Preferably, we could have access to a multi-function hall in the library (with easy access to other resources such as computers and Internet), with enough floor area to accommodate the setup of a workspace environment with re-configurable facilities such as: a number of conference desks each of which is good for at least six people; an open area with a wall-size screen for LCD-projection, for large gathering or

presentation or briefing for the whole class. The idea is that sharing and working together even in a less-than-perfect environment will be louder than in an environment where isolated students work silently from textbooks. More importantly, to make collaborative learning work, there are major tasks that the instructor should address in organizing the PBL group learning activities. First, we need to clearly specify the objectives for the lesson lest the students always guess what the professor wants: academic objectives or collaborative skills objectives. Second, we need to make decisions or devise innovative strategies about placing students in learning groups before the PBL episode begins. Third, we need to carefully explain the task, goal structure, and the learning activity. Fourth, we need to monitor the effectiveness of the PBL collaborative learning groups and intervene when necessary to re-orient the learning efforts toward pinpointed tasks, or to increase students' interpersonal and group skills. Lastly, we need to evaluate student achievement and help them discuss how well they collaborated with one another. It is also important to understand that while groups work to achieve common goals, each member should fulfill a particular role or accomplish an individual task within the group project. The teacher needs to assess both the group and the individual work.

4. THE IDEA OF A LEARNING ORGANIZATION MODEL

The concept of the learning organization took seed several decades ago and gained major recognition with the incredible success of Peter Senge's 1990 book *The Fifth Discipline*. Senge (1990, p.3) describes a learning organization as a place where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together. At the core of Senge's formulation are five essential learning disciplines: personal mastery, mental models, shared vision, team learning, and systems thinking, that may be briefly described as follows. Personal mastery has to do with individual learning, and can be seen as the basic building block through the actualization of which the learning organization is typically constructed. Mental models are about how individuals reflect on their own knowledge, using such models to improve the internal understanding of the organization's functions, and processes. Shared vision implies a sense of group commitment to a matrix of organizational goals, while team learning describes a sharing and utilization of knowledge involving collective thinking skills. The purpose of systems thinking is to understand relationships and inter-relationships, as well as the context and the forces that affect the behavior of the organization. To learner-centered teachers, it is not difficult to perceive that the learning organization model somewhat represents an educational context through which students can learn by dealing with others, exchanging ideas and comparing our ideas with other people. In fact, Lev Vygotsky's theory (1978) suggests that we learn first through person-to-person interactions and then individually through the internalization process that leads to deep understanding. This belief in the social process of knowledge sharing is based on people's mutual understanding of their own and others' interests and purposes, and the recognition that their interests are somehow bound up in doing something to which they all contribute. Indeed, at one time or another, most of us might have experienced being a member of a great team. We probably remember the trust, the relationships, the acceptance, the synergy, and the results that we achieved as a group of individuals. Though it takes time to develop the knowledge of working as a whole, when a group of people who over time have learned to enhance their capacity to create what they truly desire to create, this is, in fact, an instance of a learning organization.

On experimenting with the learning organization ideal of providing educational services, we have experienced that a major shift from the linear view to a dynamic view of managing education (Bates, 1995; Berreman 1997), must be accommodated. In the linear model of education, learning design proceeded in a linear fashion from defining objectives to lesson planning to course delivery. Educators first engaged in a comprehensive learning needs analysis process, often based on assessments done by others about competencies and learning objectives. Comprehensive syllabi were developed. Finally, the course was delivered as planned. Associated with this linear approach were a set of teaching strategies which matched its linear qualities, characterized by being predominantly one-way, centralized, and broadcast-oriented. When students appeared bored and unengaged in this type of program, the solution was to find ways to use new media to make the one-way broadcast more entertaining. Much transmissive learning was nothing more than a way to generate a broadcast of an expert and his or her multimedia slides with good production values.

Today, we need a renewed mindset for education, especially when it is offered through the learning organization model to achieve collaborative learning. Teaching and learning must be seen as an ongoing process rather than a program with a fixed starting and ending point. The importance of widespread participation by learners in the design of their own learning must be emphasized (Kimball, 1995). The first challenge for us educators is to figure out how to harass the power of the new media, say the World Wide Web, to take advantage of its capacity to support flexibility, concurrency, and just-in-time design, instead of merely using the new media to deliver the same old stuff. ICT (information and communications technologies) are particularly well suited to a more dynamic approach to managing education. Good teachers have also always been open to changing their lessons plans based on student input. New media makes it easier. And online environments can provide electronic spaces for continuing conversation among students and teachers about what is working and what is not working in the process. The idea of participatory course design is not to be neglected any longer. The availability of well-devised online environment, say, the Rich Environment for Active Learning (Vat, 2001), provides an opportunity to support collaborative learning in ways we have not been able to do before. Yet, just putting participants together in some kind of common electronic space will not turn them into a collaborative group automatically. The key is to design a framework for group work, which requires the team to grapple with roles, protocols for working inter-dependently and mutual accountability. In this regard, PBL serves as a very good instrument to experience cooperative group work.

5. THE CASE-IN-POINT DISCUSSION: SFTW300 SOFTWARE PSYCHOLOGY

The discussion presented here in the teaching of human-computer interaction (HCI) embedded in our junior core course *SFTW300 Software Psychology* (Vat, 2000; 2001a), is meant to elucidate our application of the collaborative learning principles to the course enactment, whose main thrust is to deepen the idea that HCI is concerned with understanding, designing, evaluating and implementing interactive computer applications to match the needs of people. Our purpose is to explain, through an action research perspective, how the constructivist ideas of PBL could help students develop a unified team-based approach to better manage the underlying software requirements. Owing to the space limitation, this description could only briefly cover the specific ICT usage behind our PBL initiative in the process of course delivery.

5.1 The Setup of PBL-Based Action Research

In each semester when *Software Psychology* is offered, students embark on the PBL cycle of learning through organized groups each of 4-6 members, including a team leader, a secretary, a liaison member, a project tracker and other technical staff. Each PBL group will be given a project scenario to explore within a specified period of time. Individual PBL groups are each assigned a project client from other teams. Namely, each team, acting as the developer, is to complete an interactive system design and prototype for another team acting as the client. Yet, the same team is the client of another PBL group, responsible for clarifying the project, and resolving ambiguities as they arise, through the liaison member in the developer's team. Meanwhile, each PBL developer team is required to hold requirements workshops with the PBL client team to elicit user expectations, and arrive at some working definitions of what the project is to accomplish. The team leader, somewhat equivalent to a project manager, has to coordinate the team activities, and ensure effective team communications. And team members have to help set the project goals, accomplish tasks assigned, meet deadlines, attend team meetings and participate in editing project documents to be combined as the final project report. At the end of the project, each team is obliged to present their work as it is, and lead class forums to elicit students' discussions. Each member of the respective PBL teams is also required to make a presentation of his or her project involvement, with a question and answer session for the whole class. The instructor being the project sponsors for all teams has to design the necessary scenarios to guide, motivate and provide feedback to the PBL teams. Also, the instructor has to evaluate how well students perform in the PBL groups, and how well such groups behave as self-directed work teams (SDWT) in managing project development, and provide the necessary adjustments.

5.2 Targeted Team Skills Development for HCI

To partially address the requirements challenge in software development, the author has selected the following team skills to be experienced by our PBL students within the semester's duration constraint.

- *Analyzing the Problem*. This includes a set of skills to understand the problem to be solved before application development begins. It is the process of understanding real-world problems and user needs and proposing solutions to meet those needs. We consider a problem as the difference between things as perceived and things as derived (Gause and Weinberg, 1989). Accordingly, if the user perceives something as a problem, it is a real problem, and it is worthy of addressing. Typical techniques include gaining agreement on the problem definition; understanding the root causes to induce the problem, and identifying the stakeholders and the users, with the former being anyone who could be materially affected by the implementation of the new application.

- *Understanding User Needs.* This introduces a variety of techniques to elicit requirements from the system users and stakeholders. Software teams are rarely given effective requirements specifications for the systems they are going to build. Often they have to go out and get the information they need to be successful. Typical methods include interviewing and questionnaires, requirements workshop, brainstorming and idea reduction, storyboarding, use cases derivation, role-play, and prototyping. Each represents a proactive means of pushing knowledge of user needs forward and thereby converting fuzzy requirements to those that are better known.

- *Defining the System.* This describes the initial process by which the team converts an understanding of the problem and the users' needs to the initial definition of a system or application that will address those needs. Our PBL teams should learn that complex systems require comprehensive strategies to organize information for requirements. This information could be expressed in terms of a hierarchy, starting with user needs, transitioning through feature sets, then into the more detailed software requirements. The latter could be expressed in use cases or traditional forms of requirements documents, defining at a high level of abstraction, both the problem space and the solution space.

- *Managing the Project Scope.* This reminds our teams that they should be aware not to initiate projects with too large a scope to be accomplished. Project scope is presented as a combination of the functionality to be delivered to meet users' needs, the resources available for the project, and the time allowed in which to achieve the implementation. The purpose of scope management is to establish a high-level requirements baseline for the project. The team has to establish the rough level of effort required for each feature of the baseline, including risk estimation on whether implementing it will cause an adverse impact on the schedule. Also, each team has to actively engage its customers in helping solve the scope management problem to ensure both the quality and the timeliness of the software outcomes.

5.3 The Criteria of PBL-Based Evaluation

Throughout our course delivery, we have born in mind that our research should be evaluated in part by its ability to explain practice. The following explicit criteria (Greening, 2000; Ryan, 1993; Savery and Duffy, 1995) have been defined in order to later judge the research outcome with respect to the process of problem diagnosis, action intervention, and reflective learning.

- *Learning is an active and engaged process.* Instead of being told what to do or how to solve problems, students within a PBL atmosphere are to generate their own learning issues. It is expected that a sense of ownership should be born leading to greater cognitive engagement. Students are actively engaged in working at tasks situated in an authentic setting which should lead to greater ability in transfer to other real-world contexts.

- *Learning is a process of knowledge construction.* PBL purports that learners construct their own knowledge. The constructivist epistemology states that the known is internal to the knower and is

subjectively constructed based on individual responses to experience. Thus, in order to harness the reality of learning, we need to consider the opportunity to find knowledge for oneself, contrast our understanding of that knowledge with others' and refine or re-structure knowledge as more relevant experience is gained.

- *Learners function at a meta-cognitive level.* Constructivist learning focuses on initiative thinking activities rather than working on the 'right answer the teacher wants'. Students generate their own strategies for problem formulation and possible solutions. The instructor's role is that of a facilitator, a guide or a coach, probing students' thinking, monitoring their activities, and generally keeping the process moving. Thus, PBL should promote meta-cognition through encouraging students to reflect upon the problem-solving process. It is believed that reflection on recent experiences is an effective method of learning.

- *Learning involves social negotiation.* We accept the constructivist perspective that knowledge is socially negotiated. The quality or depth of our understanding can only be determined in a social environment where we can see if our understanding can accommodate the issues and views of others and to see if there are points of view, which we could usefully incorporate into our understanding. The importance of a learning community where ideas are discussed and understanding enriched is critical to the development of our SDWTs, and thus, the design of an effective HCI environment.

5.4 The Provision of PBL-Based ICT Support

It is designed that a Web portal is needed for each course adopting the PBL initiative. This portal should lead to a Web-based organizational space for the course, OS_{Course}, which renders a number of peculiar services to teacher and students, in the form of distributed applications customizable to their PBL cycle of activities. In a specific course context, there must also be a number of Web-based collaborative spaces, CS_{PBL}, to enable group-based project work to be performed. Besides, to support the interactions among students, and between the instructor and students, the provision of a personal electronic space for either teacher or student, $PS_{Individual}$ ($PS_{Teacher}$ or $PS_{Student}$) is essential to facilitate individual work performance. The linkages from the course space, to the respective collaborative spaces, to the individual personal spaces, must be closely updated to facilitate the Web-based auxiliary processes of the teaching and learning experiences. The challenge is to ensure that the sites should complement the course enactment by enabling both teacher and students to interact asynchronously or synchronously through the different customizable services offered. The simple expression for this PBL-based ICT support (Vat, 2004) could be written as follows: $\mathbf{<ICT\text{-}Support>_{Course} ::= OS_{Course} + \{\ CS_{PBL}\ \} + \{\ PS_{Student}\ \} + PS_{Teacher}}$, where the braces {} represents the repetition of the element embedded. It is intended that the provision of the collaborative spaces in the course space could facilitate the formation of a virtual community of student learners made up of different PBL groups. It is also our experience that each PBL group, besides its CS_{PBL}, must be associated with an electronic project space, $WS_{Project}$, to develop project-based learning. Specifically, each $WS_{Project}$ is affiliated with a project sponsor (played by the instructor), a project client (played by another PBL team), a project team (any PBL group), a project mission, a project schedule (semester-long), and a number of project activities (application-specific), each of which is composed of a number of tasks. A specific task consumes resources, and produces a work-product. (See 5.2 for a set of activities chosen for our HCI-based project development). It is worth mentioning that working out the specific ICT support for the project space is always a dynamic challenge in a sense that no pre-determined set of services could satisfy all the needs of different groups of PBL students. However, the use of design scenarios to answer such questions as "what services, for whom, in what ways, under what circumstances" could help visualize the needs of individual PBL groups, such as project portfolio including milestones achieved, and the member portfolio comprising individual contributions accomplished.

6. CONCLUSION

To conclude our discussion, it might be of interest to concisely recapture our idea of the learning organization model for student empowerment, through three important lines of action as follows:

- *Enable students to determine what they need to learn through questioning and goal setting.*

It is believed that students should work to identify their knowledge and skill deficits, and to develop strategies in the form of personal learning goals for meeting those deficits. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the design of the collaborative learning environment, can guide the students in identifying what they already know and what they need to learn, then knowledge gaps and mistakes can be viewed in a positive way such as another opportunity to learn. And students can assume more responsibility in addressing their own learning needs during any instructional unit.

- *Enable students to manage their own learning activities.*

It is believed that students should be enabled to develop their learning plans, which should describe priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations, and proposed learning outcomes, including presentation and dissemination of new knowledge and skills, if applicable. Traditionally, these instructional events are arranged by teachers to be obeyed by students, in order to accomplish a specified set of pre-determined objectives. Yet, it is not advantageous for students to learn to be self-directed. To manage their own learning activities, students must be guided and supported by the teacher, through the collaborative environment, slowly taking on more and more responsibility of their own learning.

- *Enable students to contribute to one another's learning through collaborative activities.*

It is believed that students should be encouraged and supported to discuss and share their personal findings. Particularly, we should enable students to become co-builders of the course/learning resources through evaluating and refining the entries their peers put into the course depository. Collaborative group-based learning fits to achieve the purpose. Students, nevertheless, must be educated to recognize what they are trying to learn in group-work, value it, and wish to share that value with others. Teachers can provide this sense of accountability and belonging by structuring students' work in the support environment with more innovative and pragmatic pedagogical devices.

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