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Developing REALSpace: Discourse on a Student-Centered Creative Knowledge Environment for Virtual Communities of Learning

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ABSTRACT

This manuscript is to provide an action research report on the issues behind the prototyping of a student-centered creative knowledge environment (CKE), which focuses on developing student responsibility, making learning meaningful, promoting overt knowledge construction, performing learner assessment, and showcasing learner achievements. The primary idea is to create an electronic knowledge space where students are enabled to learn through constructing rich portfolios of knowledge work. The issue of learner responsibility lies in student's willingness to identify learning deficits, setting goals, managing the learning process, and monitoring the learning strategies they use. The issue of meaningful learning lies in providing students with realistic problems, which are conducive to the development of capable problem solvers. The issue of active knowledge construction lies in providing students with opportunities to engage in high-level thinking, reflection, and articulation activities, with suitable support to scaffold students in their pursuit of active learning.

Keywords: creative knowledge environment; communities of learning; communities of practice; constructivism; information and communication technologies; student-centered education; social networking; virtual communities

INTRODUCTION

In an age where innovations in social computing and the mainstreaming of electronic tools are unlocking new opportunities for blending online with face-to-face interactions (Neto & Brasileiro, 2007), high expectations have surrounded e-learning initiatives (Ertl, Winkler, & Mandl, 2007) in various sectors of our society, including our enterprises, institutes and universities. The term *e-learning* carries the connotation of flexible and efficient learning with the support of electronic media (Littlejohn & Pegler, 2007) – in particular with the help of computers and the Internet. Nonetheless, it is our belief that e-learning should make sense only when its use reflects a new culture of learning, as exemplified by that of a learning organization (Senge, 1990), whose focus lies mainly on the learner (or communities of learners) rather than merely on technology itself. To this end, the discussion presented in the manuscript is organized around story-telling our prototyping work for the student-centered (Vat, 2004b) creative knowledge environment (CKE) (Hemlin, Allwood, & Martin, 2004) from the perspective of developing socio-technical systems (Emery & Trist, 1960) enabled by the Web (or Web 2.0) technologies (Vossen & Hagemann, 2007) of today's Internet. By socio-technical systems, we mean there is an interdependent and reciprocal relationship between humans and technology; namely, both the social and the technological aspects of knowledge work need to be in harmony to increase effectiveness and to "humanize" the environment. Technically, this would be achieved mainly by user participation in the design of the systems and devices that users are to operate at the knowledge environment. Our first piece of story telling, after setting the backdrop of our organization, describes the initiative to define a new culture of learning which can be conceived as the design philosophy behind our e-learning system, providing as much student-centered virtual learning experience as deemed possible. The second item of interest elaborates on the e-learning system currently under active reshaping by our students, which is called *REALSpace* from its former version of implementation in 2000, named *REAL*, meaning a Rich Environment for Active Learning (Vat, 2001a, 2001b). Presently, we add the space concept in the form of personal, group and project workspaces respectively to broaden the ideas of collaboration and teamwork. Our third item of concerns lies in the educational potential of e-portfolios (Vat, 2008a, 2008c; Stefani, Mason, & Pegler, 2007), a renewed concept of the paper folio as a tool of reflective learning, performance assessment as well as personal development planning through the Web. The fourth story is concerned with the context of our CKE developed from the theme of problem-based learning (PBL) (Vat, 2006a, 2004a), whereas the fifth story tells of the knowledge processes behind our virtual community of learning (Vat, 2006c, 2006d). The manuscript then deliberates on the design approach of our CKE, rendered from the perspective of socio-technical systems incorporating knowledge sharing among members of the learning community. The article concludes with a relevant discussion of the problems facing our work, and some remarks of continuing challenges related to our research on student-centered inquiry-based teaching, applicable in the context of virtual communities of learning.

SETTING THE STAGE

The Department of Computer and Information Science (CIS), as a constituent unit of education under the Faculty of Science and Technology at the author's affiliated university, is installed to offer degree programs in both the undergraduate and graduate levels in Software Engineering. The department has a current population of about 150 undergraduates and 30 graduate students mostly part-time. It has to coordinate per academic year, the enactment of about 20 graduate and 40 undergraduate courses. There are currently five laboratories installed for the IT-education of our students: Software Engineering Laboratory, E-Commerce Technology Laboratory, Distributed Systems Laboratory, Computer Graphics and Multimedia Laboratory, and the Motion Capture Laboratory. Besides, there are over two hundred PC's distributed on campus, to offer 24-hour computer service to ourr students, including Internet access. To help manage course delivery, the university also provides course management systems, such as WebCT (since 1998) and MOODLE (since 2008) to teaching staff for their course enactment. Currently, the means of education delivery in our department has largely been didactic; yet, we are quite willing to blend the best of our old values of good teaching through the instructivist approach with the modern-day constructivist way of thinking such as problem-based learning (PBL) (Amador, Miles, & Peters, 2006). We are also interested in the continuing efforts to extend our curriculum and instructional practice over the Internet, through some continually renewed electronic (mostly Web-based) course support, both for the teaching staff and for the students.

Campus Network with Internet Access

Starting in 1993, our university was the first in Macau to introduce fibre-optics and structural cabling system to link all the campus computers. In 1998, our university laid the first high-speed ATM (Asynchronous Transfer Mode) network in Macau with a speed of 622Mbps, the highest standard of ATM network technology at that time. In 2000, we also got an upgraded campus network of Gigabit Ethernet with the backbone speed up to 8Gbps. Meanwhile, the university launched the "Net-Port" service around March 2000, to install network outlets in all classrooms, meeting rooms, and library auditoriums throughout the campus. Teachers and students could then connect their notebook computers to the campus network. With the beginning of 2001, our wireless campus network has incrementally been put in place. Our wireless coverage is currently over ninety percent of our campus, and is the largest wireless local area network (LAN) in Macau, allowing both teachers and students further mobility with the notebooks. To allow remote access to the campus network, we also enjoy a modem pool of about 270 dial-up lines, so that teachers and students working at home can connect their computers to the campus network with Internet access. Our Internet access service could be traced back to 1994 when the university established the first leased line to the Internet in Macau before the establishment of any local Internet Service Providers (ISP). In 2003, our university launched the "Net-VPN" (Virtual Private Network) service for students and teachers, which supports the execution of secure applications at home through broadband services provided by the local ISP. This VPN service is essential to accessing valuable e-journals our university library has subscribed. Currently, there are about 600 computers installed in the various computer-rooms and computer-laboratories distributed throughout our different faculties and institutes. With the adoption of smart-card access control and digital surveillance system, our computer rooms are currently open 24 hours a day, 7 days a week to provide the maximum access time possible for students to use the computer facilities.

Online Education with Mobile Access

In 1998, an online education working group was established in our university to examine the possible delivery of our educational services over the Internet. The university decided to use WebCT which was then available from WebCT Educational Technologies in Vancouver, Canada, as the course management software and started a staff-engagement initiative to encourage its usage in individual courses offered by various academic units. Currently, we have over 200 courses which actively rely on WebCT for Web-based course support, and around four to five thousand student accounts are set up and maintained annually. Meanwhile, with the coverage of our wireless campus network reaching over 90 percent, it is envisioned that mobile access would make various Web-based resources available for students' learning to take place anytime and anywhere on campus. The university provided notebook computers to academic staff for conducting lectures in class with the support of wireless network access. In 2002, in order to encourage more students to acquire their own notebook computers to use our wireless network facilities for learning purpose, a subsidy program was launched to help lower the cost of personal purchase of notebook computers by students. Besides, to support the university's initiative in online education, a SAN (storage area network) infrastructure was deployed to accommodate the various amount of storage required for different types of important data, say, user e-mails, research profiles, and other necessary database records like the course archives. The SAN system consolidates data from the heterogeneous environment of storage systems distributed over various server-computers, onto a single platform for centralized management and resource sharing. It now supports more than several thousand users including teachers, students and administrative staff.

DEFINING A NEW CULTURE OF LEARNING

Against the backdrop of the university's top-down IT efforts in support of online education, our discussion begins with the reflection of some bottom-up course-support initiative sustained by individual staff members from the Department of CIS. In particular, this reflection is based on the experience acquired through the construction of a Web-enabled course support environment for learner-centered education starting in 1999. This project, then given an acronym "REAL" with the connotation of a Rich Environment for Active Learning (Vat, 2000, 2001a, 2001b; Grabinger & Dunlap, 1995), has brought in fresh insights concerning the scholarship of teaching and learning with a student-centered orientation. Such insights have become some of the constituent themes behind our new culture of learning to be properly described as follows.

Managing Education the Dynamic Way

In the traditional linear model of education, learning design proceeded in a linear fashion from defining objectives to lesson planning to course delivery (Bresciani, 2006; Wehlburg, 2006). Educators first engaged in a comprehensive learning needs analysis. Then suitable syllabi were developed. Lastly, the course was delivered as planned. Associated with this linear approach were a set of teaching strategies characterized by being predominantly one-way, centralized, and broadcast-oriented. Today, we also need a dynamic model of education (Bates, 1995) which asks of us the importance of collaborative learning. Teaching and learning is often seen as an ongoing process (Savory, Burnett, & Goodburn, 2007) rather than a program with a fixed starting and ending point. The essence of widespread participation by learners in the design of their own learning must be emphasized. This dynamic view of managing education, especially in software engineering, is increasingly popular in an age of lifelong learning, when more and more adult and mature learners appreciate the idea that true learning is based on discovery guided by mentoring rather than by the transmission of knowledge. Indeed, one of the meaningful directions of education is to be away from the obsession with knowledge reproduction, and to move towards the practice with collaborative knowledge construction (Boss & Krauss, 2007). There must be an emphasis on contextualization of the learning scenario, providing a basis for later transference, and learning is accompanied by reflection as an important meta-cognitive exercise. The implementation of problem-based learning (PBL) (Amador, Miles, & Peters, 2006; Vat, 2004a) via group-based project work represents a vehicle of this educational perspective, where meaning is not transmitted. Instead, learning occurs as a process of adjustment of existing concepts, and understanding is based on interaction among a complex weave of factors, such as the learners' goals and existing concepts, the content of the learning experience, and the context where the learning occurs. More importantly, social negotiation and viability (Vygptsky, 1978) are the principal forces involved in the evolution of knowledge. They ensure that learning is anchored both by the learning community (say, PBL groups of students), and by the need to test constructions against reality. The effects of such testing are the adjustments in the structure of concepts held by the learner. All these are valuable experiences in the future professional practice of our student software engineers.

Teaching the Constructivist Mode of Learning

For quite a while, we have been witnessing a growing tendency away from the conventional transmissive pedagogy in higher education, towards a pedagogy that can broadly be characterized as constructivist (Greening, 2000). By transmissive pedagogy, we mean teaching based on the assumption that the development of knowledge results from learning facts and routine, and knowledge is an entity that can be transferred from one person (the teacher) to another person (the learner). Namely, in many learning scenarios, the teacher plays an active role, and the students simply act as passive recipient of the knowledge presented and slot it straight into an empty place in their knowledge base, or at best, work on it later to make it their own. By constructivist pedagogy (Vat, 2004b; Duffy & Cunningham, 1996), we mean an approach to learning through a variety of knowledge building processes, and that teaching should encourage students to work actively towards understanding within a framework of personal responsibility and institutional freedom. Within the culture of transmissive teaching, what constitutes good learning has largely been based on success in examinations designed to test the quantity and the quality of what individual students have learned, in the sense of giving back, in an appropriate form, that which the teachers taught and the textbooks told. The constructivist shift brings new dimensions to the notion of good learning, such as being able to find information and knowledge by oneself; of being able to look critically at what one finds; of being able to question one's teachers; of being able to collaborate with colleagues; and of being able to discuss what one knows with one's peers and with the public. Accordingly, as the need to look at the student's work as a whole is increasingly emphasized, the notion of good teaching shifts away from the role of presenter and towards the much more complex role of guide and coach. In the specific context of problem-based learning (Greening, 1998; Evensen & Hmelo, 2000) the systemic efforts to coach students' active learning should include: Firstly, the learner should be involved in an authentic experience that genuinely interests him or her. Secondly, within this experience, the learner should encounter some genuine problem that stimulates thinking. Thirdly, in solving the problem, the learner must acquire information and form possible, tentative solutions that may solve the problem. Fourthly, the learner must test these solutions by applying them to the problem. Indeed, the iterative sequence of observation, interpretation, and application helps the learner to better understand the process of problem solving and become a better self-directed learner. This is indeed an important quality expected of professional software engineers.

DEFINING REALSPACE FOR COMMUNITY-BASED LEARNING

The idea behind our *REALSpace* project is to build on top of the REAL concept (Vat, 2001a, 2001b) put in place in 2000 with the participation of a group of graduating seniors. Indeed, the REAL experiment, though later closed owing to the introduction of the WebCT, had indeed created many possibilities to enhance communications between teachers and students, while retaining the familiar face-to-face classroom interaction, as one of the essential aspects of a learning process. It has been our lessons learned that interaction as an important component of education must be intentionally designed into the instructional process in order to improve the quality of learning (Perkins, 1991; Su, Bonk, Magjuka, et al., 2005). Thereby, the design of *REALSpace* is to incorporate what the era of Web 2.0 is to offer in terms of blended e-learning. As instructional designers, the guiding question in tackling the *REALSpace* project is this: How do we create a technology-enhanced and managed learning environment where people (including students and teachers) naturally connect, and where students in particular as members of a learning community should engage themselves in the types of activities that will take on their initiative and responsibility for their own learning?

Enabling User Participation and Contribution

The instructional design of user experience in the *REALSpace* is to extend the service of a good teacher, by increasing student participation, communication, and contributions through re-designing the delivery of college lectures to incorporate more student activity and instructor feedback. The environment is expected to develop students' ability to generate problems, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use knowledge. Through reviewing the experiences gained from our REAL project, we have retained the following ideas of student empowerment (Vat, 2004b; Collins, Brown & Newman, 1989; Grabinger & Dunlap, 1996; Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989; Vygotsky, 1978), in the *REALSpace*:

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

It is convinced 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. Also, they should learn to relate what they know to what they do not know and ask questions to guide their quest for new knowledge. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the *REALSpace*, can guide the students in the identification of 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.

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

It is convinced that students should be enabled to develop their learning plans (O'Donnell & Caffarella, 1990), 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 followed by students throughout a semester or school year, in order to accomplish a specified set of pre-determined learning or assessment objectives. Yet, in that case, it is not advantageous for students to learn to take the initiative. To manage their own learning activities, students must be guided and supported by the teacher in the *REALSpace*, slowly taking on more and more responsibility of their own learning.

c. *Enable students to contribute to each other's learning through collaborative activities.*

It is convinced that students should be motivated and supported in discussing and sharing information. Particularly, we should enable students to become co-builders of the course- or subject-related resources through evaluating and refining the entries their peers put into the *REALSpace*. Collaborative learning seems appealing to achieve that purpose; however, it involves not just creating a group and then dividing up the work. Students must be educated to recognize what they are trying to learn in teamwork, value it, and wish to share that value with others. Teachers can provide this sense of accountability by structuring the group work to include both individual and group assessments.

Managing the Mechanisms of REALSpace

There are a number of service components (Vat, 2007) conceived in the *REALSpace* providing support for user (or learner) participation, communications and contributions, examples of which include the blogs, the Wikis, the RSS, the podcasts, and the social networks (Richardson, 2006) enabling the Web today as a communication medium, a socialization platform, a discussion forum, a storage device for the learner diaries, and as a constantly growing and expanding knowledge space.

The Blogs

A blog (Budd, Collison, Heilemann, et al., 2006) is an online diary or a journal that a person is keeping and updating on an ad hoc or a regular basis. The word itself is a shortened version of Web log, resembling the logs kept by the captain of a ship as a written record of daily activities and documentation describing a journey of the ship. A blog on the Web is typically a sequence of short texts in which entries appear in reverse order of publication so that the most recent entry is always shown first. In fact, blogs as a form of communications are typically expressions of personal or professional opinion or experience on which other people can at most comment.

The Wikis

A wiki (Choate, 2008) is a Web page or a collection of pages that allows its users to add, remove, and generally edit some of the available content, sometimes without the need for prior registration if the wiki is a public one. The term "wiki" is derived from the Hawaiian word "wikiwiki" which means "fast", suggesting a fast medium for collaborative publication of content on the Web. The history of wikis started in March 1995 when Ward Cunningham (Leuf & Cunningham, 2001), a software designer from Portland, Oregon, was working on software design patterns and wanted to create a database of patterns so other designers could contribute by refining existing patterns or by adding new ones.

The RSS

RSS stands for Really Simple Syndication (Holzner, 2006), but contextually carries the connotation of rich site summary. RSS is a technology that allows educators to subscribe to "feeds" of the content that is created on the Internet, whether it is written in a Weblog or in a more traditional space such as newspapers or magazines. In other words, just as in our traditional models of syndication content comes to the readers instead of the reader retrieving the content. From a research and information management perspective, RSS may be an extremely useful application for education.

The Podcasts

A podcast (King & Gura, 2007) is a series of portable sound files, hosted on the Web, and distributed via a Really Simple Syndication (RSS) feed, which enables each episode of the series to be pushed to subscribers. So, it is the distribution piece of podcasting that has caught our attention in education, because although we have been able to do digital audio for some time now, getting people to listen to it has not been easy. Yet, with podcasting, this expectation has been made hopeful. Moreover, what makes podcasting different from an audio file posted on the Web is the power of XML (a scripting language) to have the most recent episode sent to the top of the list because a successful podcast is often part of a series.

The Social Networks

The idea of social networks (Levene, 2006) brings another dimension to the Web by going way beyond simple links between Web pages; they add links between people and communities. In a social network, direct links will typically point to our closest friends and colleagues, indirect links lead to friends of a friend, and so on. In particular, a social network on the Web often focuses on building an online community for a specific purpose. People with different interests are often connected with social networks, and their interests could relate to a specific hobby, a medical problem, or an interest in some specific art or culture. Oftentimes, a social network can act as a means of connecting employees of distinct expertise across departments and organizational branches, and help them build profiles to support knowledge sharing.

Personalizing our REALSpace

The original REAL project (Vat, 2000, 2001a, 2001b), conceived to provide a Web-based course-support environment for active learning among undergraduate students, was aimed to make our educational delivery more efficient, more enriched, and more learner-centered according to its instructional design. The *REALSpace* as a personalized environment, collectively constitutes a course-specific web-site for students to look up course-related information and various electronic spaces (personal space, group space, and project space) to manage (accrue and document) course-specific learning, as well as a collaborative Web-based inquiry service (CWIS) for students and teachers to interact asynchronously (Vat, 2001b) for such activities as initiating inquiry requests, co-creating related content, responding to posted questions, and archiving related queries for later references or frequently asked questions (FAQs).

As developers of learning environments, we are often confronted with the issue of design outcome: What should be the outcome of the learning process using the environment? What personalized evidence (or sorts of data or learning artifacts, such as student contributions, say, homework, project report, demo videos) do we need to justify the learning outcome acquired? In this regard, we identified with Laurillard (1993) who argues that the production of a clear set of educational objectives at the start of the project is crucial. Yet, with the prototyping experience of REAL behind us, and that of the *REALSpace* in progress, we once again confirmed the experience of Vaughan (1994) who suggests that the objectives of any project are something that evolves from an initial inspiration. There has been a considerable amount of work in developing the initial idea into a specification of the objectives for a project like REAL and the current *REALSpace*. Actually, the prototyping experience demonstrates that as instruction begins to move towards more learner-centered, the instructional design process must include a number of strategies to accommodate the likely needs of users (teachers/learners). Technically, this involves creating a series of function prototypes to clarify the objectives of the system in light of design exploration between the designer and the users (teachers and students), so that the users gradually understand what can be achieved with the technology. The formative assessment derived from the examination of different skeletal prototypes leads to a clarification of a number of analytic issues in the area of personalizing the learning outcome. It is the idea of electronic portfolio carrying a collection of electronic files used to support development, dissemination, reflection and/or assessment, which has become our area of concerns.

DEFINING THE EDUCATIONAL POTENTIAL FOR E-PORTFOLIO

E-portfolios at one level are another tool in the e-learning armory (Vat, 2008a, 2008c; Jafari & Kaufman, 2006). Both e-learning and e-portfolios address many of the same issues such as lifelong and personalized learning, flexible and student-centered pedagogies, Web-based teaching and new forms of assessment. Indeed, learning and portfolios are key concepts, and digitizing them is simply the reflection of other technology trends and developments. It has been argued that online connectivity is transforming the practice of learning (Rennie & Mason, 2004), and e-portfolios are becoming more significant than e-learning. Imagine that e-portfolios were to suddenly take off, and everyone would have a personal online space where they would store their life's work and make presentations of it in different formats for an array of different audiences: friends and family, school and higher education, workmates and job interviews. It would be a repository for all their accomplishments, their hopes and their reflections. It would stay with them for life and be a constant updatable companion: say, a diary, a resume, a record, a forward planner. That is the promise of e-portfolios in the long run.

Relating to E-Learning

In fact, different portfolios (Stefani, Mason, & Pegler, 2007) have been used by students at traditional universities and colleges where face-to-face teaching is the dominant mode of teaching. For example, course portfolios are those assembled by students for individual courses. They document and reflect upon the ways in which the student has met the outcomes for that particular course. Instructor's endorsement is often required to authenticate the course portfolios. Program portfolios are developed by students to document the work they have completed, the skills they have learned, and the outcomes they have met in an academic department or program. The mentor or appraiser could add comments. It could be a requirement for graduation. Students might use a selection from their program portfolio to show to prospective employers. Whatever the primary focus of engagement with students, the use of e-portfolios inevitably adds a strong online element to the teaching and learning. Institutions need to provide electronic support and services; teachers need access and skills to integrate the e-portfolio application into their overall course design, and students need a wide range of electronic abilities in order to develop their e-portfolio. The underlying pedagogy of e-portfolio use is considered the most significant link with e-learning. Our experience has indicated that constructivism (Vat, 2000, 2002; Bangert, 2004) does seem to be the approach worthy of repeated experimentation. The aim of constructivist principles as applied to e-learning is to engender independent, self-reliant learners who have the confidence and skill to use a range of strategies to construct their own knowledge (Eklund et al, 2003; Stacey, 1998; Slavin, 1994). Where students are required to develop and maintain an e-portfolio, they are usually expected to reflect on their learning, consider how to give evidence of their learning and possibly even develop a plan (or a learning contract) of what they would like to learn. In other words, an e-portfolio implementation of constructivism usually implies a considerable level of learner autonomy and initiative, of learner responsibility for their learning and of opportunities to refine their learning based on feedback from the teacher and their peers. More importantly, e-portfolio use can be the basis for several student-centered initiatives (Batson, 2005), including: creating a system of tracking student work over time, in a single course, with students and faculty reflecting on it; having a more fully informed and constantly updated view of student progress in a program, which is very helpful in formative assessment; aggregating other students' work in a particular course to see how the students as a whole are progressing toward learning goals; and assessing other courses in similar ways that are all part of one major and thus assessing the entire program of study.

Designing e-Portfolio as a Tool for Learning

Over the course of a student's life, the e-portfolio will need to play a variety of roles. The ease with which the digital form can be adapted, linked and transported is essential to the emergent new ways of using the idea of a portfolio. One example is an electronic showcase of student work and skills. Often the purpose is to present student work to prospective employers, or to obtain a place on a post-graduate course. It is a showcase of the student's versatility and an indicator of his or her potential. Besides providing a means of presenting evidence of learning and achievement, the e-portfolio can be a reflective document spanning the student's development and helping learners to become critical thinkers. This idea is often linked to the use of a portfolio as a personal development plan (PDP) (Lorenzo & Ittelson, 2005). As a specific tool of learning, we see the development of the e-portfolio over time as an important aspect of learning. The emphasis is on the development process and what this offers the student, rather than on a polished end product, no matter how versatile. In this light, we identify with DiBiase et al. (2002) concerning the development of a portfolio from simple collection of materials, through selection, reflection and projection to final presentation.

- ***Collection of Materials***
  Students, with support from teachers, save artifacts such as assignments, project reports, and presentations that represent achievements, and successes in their day-to-day study.
- ***Selection of Materials***
  Students review and evaluate potential portfolio material to identify those that demonstrate the development of particular skills or achievement of specific standards.
- ***Reflection of Work Done***
  Students evaluate or assess their own learning through reflective commentary. They reflect on their own growth and development over time, recognizing achievement of goals and standards, identifying gaps in development or understanding and acknowledging skills requiring further work.
- ***Projection of Work to Accomplish***
  Students, with the teacher's assistance, compare current achievements or outcomes to standards or performance indicators. They then set learning goals or develop action plans for the future. This stage links portfolio development and personal development planning (PDP) to support lifelong learning.
- ***Presentation of Achievements***
  Students are invited to share their portfolio with teachers and possibly with peers. This promotes collaborative learning, fosters self and peer evaluation and further encourages commitment to PDP and lifelong learning.

DEFINING THE STUDENT-CENTERED CREATIVE KNOWLEDGE ENVIRONMENT

Our major focus of student-centeredness lies in the creative knowledge environments (CKE) by which we mean the environments in which new knowledge is produced by people (teachers and students), especially in their respective work and study settings. In particular, we can consider CKEs as the creative units for people on a number of scales. The smallest is perhaps the environment surrounding one individual trying to solve a problem in his or her laboratory, or a small team or work group, collaborating to find creative solutions in its search for innovations, such as a university department seeking innovative ways of doing world-class teaching and research. Nonetheless, an important area of concerns for our student-centered CKEs is the need to identify the causal and other relationships linking factors that exert a positive or negative influence on students engaged in creative problem solving. As is well known from science and technology studies (Hemlin, Allwood, & Martin, 2004), knowledge is socially negotiated and constructed: it becomes established as knowledge in a process involving social communication. A state-of-the-practice example to this knowledging process can be illustrated from the four roles of the creative process introduced by Roger von Oech (1986): the explorer, the artist, the judge, and the warrior. It is our observation that creativity in problem-solving can be enhanced by exercising mental agility to move between these different roles. Yet, knowing how and when to change character roles requires students' deliberate learning. And it is crucial that we spare some time for our students to practice and perfect this art of creative knowledge work.

- ***The Explorer***
  As creative problem solvers, we need the raw materials from which new ideas are made: facts, concepts, experiences, knowledge, feelings and whatever else we can find. As the explorer, we venture off the beaten path (same old places) to gather information on an issue, researching the necessary problem before any solution set exists. Activities include reading, asking others about their views, and deciding which issues need additional work or definition.

- ***The Artist***
  The ideas gathered in the explorer stage, will be like so many pieces of colored glass at the end of a kaleidoscope. They may form a pattern, but if we want to seek out a variety of different kinds of information, we will have to give them a twist or two. That is when we shift roles and let the artist in us come out. This character generates new ideas in the problem-solving phase. This phase is the most energetic and active because we have to re-arrange things, look at them backwards, and turn them upside down. We ask what-if questions and look for hidden analogies. New problem definitions, potential solutions, and alternative next paths for action are often produced here.
- ***The Judge***
  After all the experiments with a variety of approaches, we may come up with a new idea, and we ask ourselves, "Is this idea any good? Is it worth pursuing? Will it give us the return we want? Do we have the resources to make this happen?" To help us make our decision, we adopt the mindset of a judge. This character evaluates and filters the ideas that have been generated. At this stage, we critically weigh the evidence. We look for drawbacks in the idea and question our underlying assumptions. Eventually, some ideas must be discarded – a task that is less appealing to creative folks. Yet, new ideas will not emerge if the judge is in charge at the beginning of the brainstorming process.
- ***The Warrior***
  Finally, after we make a decision, it is time to implement our idea. However, we realize that the world is not set up to accommodate every new idea that comes along. Oftentimes, there is a lot of competition out there. If we want our idea to succeed, we will have to take the offensive. So, we become a warrior and take our idea into battle. This character champions a particular idea and sets the course for the next round of problem solving. This includes planning how the idea will be tested, evaluated and developed. As a warrior, we are part general and part foot-soldier. We develop our strategy and commit ourselves to reaching our objective. We may have to overcome excuses, idea killers, temporary setbacks, and other obstacles. But we must have the courage to do what is necessary to make our idea a reality.

Positioning the Context of Student-Centered CKEs

If the motivation behind our *REALSpace* were to encourage student responsibility, to making learning meaningful, and to encourage active knowledge construction in the specific curricula of students' study, the naturalistic creation of virtual communities of student-learners in the process of using the underlying CKE services, must be well supported. As a knowledge-support environment, there are many possibilities for further refinement. Currently, the challenges of how to enhance the value of course-specific knowledge work have rendered, at least, three main design reflections: 1) support the actual practices and daily tasks of the participants (teachers and students); 2) collect experiences and represent them in an accessible and equitable manner; and 3) provide a framework to guide the knowledge process.

- *Support the actual practices and daily tasks of the participants*
  The CKE environment should support the actual practices and daily tasks of teachers by helping them guide students' learning process through the creation of a visible history of student work. For students, the CKE should support learning practices and tasks by making the thinking of their peers more visible, and by illustrating the process of collaborative problem solving through both individual and group inquiry (say, in the form of various wikis). Moreover, from a knowledge integration perspective, the practice of teaching and learning involves developing a repertoire

of models for explaining situations (say, in the form of various podcasts). What type of knowledge integration framework can best help students and teachers in their daily practice?

- *Collect experiences and represent them in an accessible and equitable manner*
  The CKE environment should collect experiences and represent them in an accessible and equitable manner to promote the process of connecting ideas so that participants (students and teachers) can use them in consequential tasks such as during follow-up clarification and illustration. Communities, if viewed as a network of relationships and resources, can be structured to elicit ideas, develop shared understanding, and promote the integration of a diverse set of perspectives. It is important to investigate the potential of structuring discussions in different ways based on the type of discussion and the associated pedagogical goals. Linking different types of pedagogical goals to design strategies is a challenging task because most of the students are yet to get accustomed to reflecting on the nature of their contributions.
- *Provide a framework to guide the knowledge process*
  The CKE environment should encourage participants to make sense of their learning by creating a culture where people ask each other for justification and clarification (Linn & Hsi, 2000). It is essential to investigate how participants adjust their learning behavior as their peers prompt them to support their ideas with evidence (Cuthbert et al, 2000). One strategy is to create some commonly agreed upon criteria and to examine how these criteria are adopted and transformed by community members (mostly students) as they interact with one another. For communities to maintain coherence and develop a sense of what is desirable behavior, it is important that a strong community culture be established with a common set of values and criteria for making contributions (Brown, 1992). Communities need a general framework to help define the mission and vision for their knowledge process.

Adopting the CKE Theme of Problem-Based Learning (PBL)

Indeed, the CKE refinement of our *REALSpace* could be considered as a creative interplay between inspiration and the educational formalisms which discipline the shape of our project, especially in areas related to supporting students' project work in groups (Guzdial, Kolodner, Hmelo, et al., 1996). Since 2001, we started experimenting with different strategies of the constructivist teaching (Squires, 1999; Duffy & Cunningham, 1996; Honebein, Duffy & Fishman, 1993) to tailor the incremental development of our CKE environment. The pedagogy of constructivism (Perkins, 1991), according to Boyle (1997), represents the dominant intellectual trend in the design of modern virtual learning environment. Constructivists argue that experiencing and becoming proficient in the process of constructing knowledge is important. Namely, learning how to learn, how to construct and refine new meaning, on the part of the learner is of most concern. In group project work, the CKE environment must support the actual practices and daily tasks of our teachers and students. We must provide a clear framework to guide the knowledge process, in order to encourage student responsibility, decision making, and intentional learning in an atmosphere of collaboration among students and teachers. We need to promote a sense of curiosity within meaningful, authentic and information-rich contexts. We also need to utilize participation in activities that promote high-level thinking processes, including problem solving, experimentation, original creations, discussion, and collective examination of topics from multiple perspectives. On examining the varied work of the constructivist literature (Duch, Groh, & Allen, 2001; Evensen & Hmelo, 2000; Albanese & Mitchell, 1993; Bruer, 1993; Barrows, 1985, 1986), we came to realize the potential of problem-based learning (PBL) (Vat, 2006a, 2006b; Savery & Duffy, 1995) in supporting various learning scenarios, especially in group-based project work, largely required in our undergraduate Software Engineering program. In the PBL approach, students work in small learning teams, bringing together collective skill at acquiring, communicating, and integrating information. Complex, real-world problems are used to motivate students to identify and research the concepts and principles they need to know to work through those problems (Boud & Feletti, 1997). PBL addresses directly many of the recommended and desirable outcomes of an undergraduate education (Wingspread, 1994); specifically, the ability to do the following (Boyer, 1998):

- Think critically and be able to analyze and solve complex, real-world problems;
- Find, evaluate, and use appropriate learning resources;
- Work cooperatively in teams and small groups;
- Demonstrate versatile and effective communication skills, both verbal and written;
- Use content knowledge and intellectual skills acquired at the university to become continual learners.

Using the PBL Cycle of Collaboration

Operationally, the PBL approach follows a cyclical process of problem solving:

- 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 the facilitator (instructor) 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.
- Students are presented with a problem (case, research paper, videotape, for example). Students working in relatively permanent groups organize their ideas and previous knowledge related to the problem and tackle to define the broad nature of the problem.
- Throughout the ensuing episodes of discussion, students pose questions (referred to as learning issues) that delineate aspects of the problem they do not understand. These learning issues are recorded by the group and help generate and focus discussion. Students are continually encouraged to define what they know and – more importantly – what they do not know.
- Student rank, in order of importance, the learning issues generated in the session. They decide which questions will be followed up by the whole group and which issues can be assigned to individuals, who later teach the rest of the group. Students and instructor (more appropriately called the facilitator) also discuss what resources will be needed to research the learning issues and where they could be found.
- When students reconvene, they explore the previous learning issues, integrating their new knowledge into the context of the problem. Students are also encouraged to summarize their knowledge and connect new concepts to old ones. They continue to define new learning issues as they progress through the problem. Students should soon see that learning is an ongoing process and that there will always be (even for the teacher) learning issues to be explored.

Reflecting on the Knowledge Potential of PBL

Problem-based learning, according to Barrows (1986), 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. PBL 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 his or her own learning needs. Knowledge gained is fed back into the problem in an iterative loop (Ryan, 1993; Margetson, 1994). PBL allows the synthesis of topics and subjects. According to Woods (1994), one specific advantage of this approach is increased motivation; namely, learners learn because they are interested. More importantly, Woods maintains that because of the way in which knowledge is acquired in PBL, links are provided with experience which help in future recall. This is invaluable for students' future professional life (Barrows, 1986). There are common themes in the literature on PBL. Firstly, as mentioned previously, PBL is usually conducted in small groups (Neufeld & Barrows, 1974; Barrows, 1988; Woods, 1994). Learning is self-directed, with emphasis on a learner-centered as opposed to a teacher-centered approach. PBL is also held to promote life-long learning and make knowledge relevant by placing it in context. The small group format (Schrage, 1990) of PBL is invaluable in the development of negotiation, communication and collaborative skills. Students also develop inquiry, thinking and problem-solving skills. Peer-based and/or self-assessment helps the individual to become a reflective practitioner; namely, there is an expectation that the PBL student becomes a more active partner in the educative experience as a result of planning, organizing, and evaluating his or her own learning (Boud, 1985; Woods, 1994).

Designing the ICT Support for PBL-Based CKE

It has been designed (Vat, 2006a) 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 particular course, OS_{Course}, which renders a number of peculiar services to teacher and students, in the form of distributed applications, which are also 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}, (also named group space) to enable group-based project work to be performed. Actually, each PBL group is given a separate CS_{PBL}. Besides, to support the interactions among students, and between the instructor and students, the provision of a personal electronic space for individual user including both the teacher and the student, $PS_{Individual}$ ($PS_{Teacher}$ or $PS_{Student}$) is essential to facilitate individual learning needs. The linkages from the course space, to the respective collaborative spaces, to the individual personal spaces, must be closely updated to facilitate the auxiliary processes of the teaching and learning over the Web. 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 (information and communications technologies) support could be written as follows (Vat, 2005a, 2006a): **<ICT-Support>$_{\textbf{Course}}$ ::=** $\boldsymbol{OS}_{\textbf{Course}} + \{\ \boldsymbol{CS}_{\textbf{PBL}}\ \} + \{\ \boldsymbol{PS}_{\textbf{Student}}\ \} + \boldsymbol{PS}_{\textbf{Teacher}}$, 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, an extension of the PBL concept to any project development work in Software

Engineering. Specifically, in a project course, 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. 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.

DEFINING OUR VIRTUAL COMMUNITY OF LEARNING

Literally, the term virtual community is not hard to understand, yet it is slippery to define owing to its multi-disciplinary nature. In order to develop virtual communities – a complex practical activity, a disciplinary definition is needed to guide the practices. According to Jenny Preece (2000, p.10), an online community consists of four important elements: the people, who interact socially as they strive to satisfy their own needs, or perform special roles, such as leading or moderating; a shared purpose, such as an interest, need, information exchange, or service that provides a reason for the community; policies, in the form of tacit assumptions, rituals, protocols, rules, and laws that guide people's interactions; and computer systems, to support and mediate social interaction and facilitate a sense of togetherness. Indeed, this definition is sufficiently general to apply to a range of different communities, including physical communities that have become networked and those that are embedded in Web sites (Lazar & Preece, 1998). Understandably, it is not trivial to develop successful virtual communities which satisfy their members' needs and contribute to the well-being of the community. The role of the community developer is to work with community members to plan and guide the community's social evolution. Putting basic policies in place helps members know how to behave, what to expect from each other, and provides a framework for social growth. As the community develops and forms its own character, its social policies and structure also evolve. Sociability is concerned with planning and developing social policies which are understandable and acceptable to members, to support the community's purpose. The premise is that members, or participants, in any community are engaged in learning that is critical to the survival and reproduction of that community. Through community participation, learners find and acquire models and have the opportunity themselves to become models and apprentices of others (Vat, 2008b; Wenger, 1998; Wenger McDermott, & Snyder, 2002). This assumption provides a basis for thinking about the possibilities of a virtual community and the dynamics of its construction across a variety of computer-based contexts. The design and refinement of technology as the conduit for extending and enhancing the possibilities of constructing virtual communities is an essential issue, but the role of the individuals as participants in such a community, is as important. The goal of our virtual community of learning is to bring about continual learning and growth for the community in need. The emergent challenge of such a mission is to de-marginalize many of the non-technical issues of building virtual communities for knowledge transfer and learning.

Conceiving the Community's Knowledge Processes

In order to facilitate the stewarding of knowledge through cultivating various online communities of learning (CoL) in our *REALSpace*, it is important to have a vision that orients the kind of knowledge we must acquire, and wins spontaneous commitment by the individuals and groups involved in knowledge creation (Dierkes, Marz, and Teele, 2001; Kim, 1993; Stopford, 2001). This knowledge vision should not only define what kind of knowledge the communities should create in what domains, but also help delineate a framework of knowledge synthesis illustrating how our CoLs and knowledge bases will evolve in the long run (Leonard-Barton, 1995; Nonaka and Takeuchi, 1995). What follows is our appreciation of three important knowledge processes considered as indispensable in the daily operations of our CoLs (Vat, 2006c, 2006d). Of particular interest here is the idea of appreciative settings, which according to (Vickers, 1972 p.98), refer to the body of linked connotations of personal interest, discrimination and valuation which we bring to the exercise of judgment and which tacitly determine what we shall notice, how we shall discriminate situations from the general confusion of ongoing event, and how we shall regard them.

- **The personal process:** Consider a human being as an individual conscious of the world outside his or her physical boundary. This consciousness means that we can think about the world in different ways, relate these concepts to our experience of the world and so form judgments which can affect our intentions and, ultimately, our actions. This line of thought suggests a basic model for the active human agent in the world. In this model we are able to perceive parts of the world, attribute meanings to what we perceive, make judgments about our perceptions, form intentions to take particular actions, and carry out those actions. These change the perceived world, however slightly, so that the process begins again, becoming a cycle. In fact, this simple model requires some elaborations. First, we always selectively perceive parts of the world, as a result of our interests and previous history. Secondly, the act of attributing meaning and making judgments implies the existence of standards against which comparisons can be made. Thirdly, the source of standards, for which there is normally no ultimate authority, can only be the previous history of the very process we are describing, and the standards will themselves often change over time as new experience accumulates. This is the process model for the active human agents in the world of individual learning, through their individual appreciative settings. This model has to allow for the visions and actions, which ultimately belong to an autonomous individual, even though there may be great pressure to conform to the perceptions, meaning attributions and judgments, which belong to the social environment, which, in our discussion, is the community of learning.
- **The social process:** Although each human being retains at least the potential selectively to perceive and interpret the world in his or her own unique way, the norm for a social being is that our perceptions of the world, our meaning attributions and our judgments of it will all be strongly conditioned by our exchanges with others. The most obvious characteristic of group life is the never-ending dialogue, discussion, debate and discourse in which we all try to affect one another's perceptions, judgments, intentions and actions. This means that we can assume that while the personal process model continues to apply to the individual, the social situation will be that much of the process will be carried out inter-subjectively in discourse among individuals, the purpose of which is to affect the thinking and actions of at least one other party. As a result of the ensuing discourse, accommodations may be reached which lead to action being taken. Consequently, this model of the social process which leads to purposeful or intentional action, then, is one in which appreciative settings lead to particular features of situations as well as the situations themselves, being

observed and interpreted in specific ways by standards built up from previous experience. Meanwhile, the standards by which judgments are made may well be changed through time as our personal and social history unfolds. There is no permanent social reality except at the broadest possible level, immune from the events and ideas, which, in the normal social process, continually change it.

- **The organizational process:** Our personal appreciative settings may well be unique since we all have a unique experience of the world, but oftentimes these settings will overlap with those of people with whom we are closely associated or who have had similar experiences. Tellingly, appreciative settings may be attributed to a group of people, including members of a community, or the larger organization as a whole, even though we must remember that there will hardly be complete congruence between the individual and the group settings. It would also be naïve to assume that all members of a community share the same settings, those that lead them unambiguously to collaborate together in pursuit of collective goals. The reality is that though the idea of the attributed appreciative settings of an organization as a whole is a usable concept, the content of those settings, whatever attributions are made, will never be completely static. Changes both internal and external to the community will change individual and group perceptions and judgments, leading to new accommodations related to evolving intentions and purposes. Subsequently, the organizational process will be one in which the data-rich world outside is perceived selectively by individuals and by groups of individuals. The selectivity will be the result of our predispositions to "select, amplify, reject, attenuate or distort" (Land, 1985, p.212) because of previous experience, and individuals will interact with the world not only as individuals but also through their simultaneous membership of multiple groups, some being formally organized, and others informally. Perceptions will be exchanged, shared, challenged, and argued over, in a discourse, which will consist of the inter-subjective creation of selected data and meanings. Those meanings will create information and knowledge which will lead to accommodations being made, intentions being formed and purposeful action undertaken. Both the thinking and the action will change the perceived world, and may change the appreciative settings that filter our perceptions. This organizational process is a cyclic one and it is a process of continuous learning, and should be richer if more people take part in it. And it should fit into the context of a virtual community of learning.

Illustrating the Community Scenario of Knowledge Synthesis

From the discussion built up so far, we can understand that knowledge synthesis (or creation and transfer) is a social as well as an individual process. Sharing tacit knowledge requires individuals to share their personal beliefs about a situation with others (Nonaka, 2002). At that point of sharing, justification becomes public. Each individual is faced with the tremendous challenge of justifying his or her beliefs in front of others – and it is this need for justification, explanation, persuasion and human connection that makes knowledge synthesis a highly dynamic process (Markova & Foppa, 1990; Vat, 2003). To bring personal knowledge into a social context, within which it can be amplified or further synthesized, it is necessary to have a field that provides a place in which individual perspectives are articulated, and conflicts are resolved in the formation of higher-level concepts. In the specific context of our *REALSpace*, this field for interaction is provided through a virtual platform for the community of learning, participated by both student and teacher members largely coming from different courses of study. It is a critical matter for our department or faculty to decide when and how to establish formal ties across different virtual communities of learning in which individuals can meet and interact face-to-face. Yet, the virtual contact of any such community should trigger organizational knowledge synthesis mainly through several stages of development. First, it facilitates the building of mutual trust among members, and accelerates creation of an implicit perspective shared by members as tacit knowledge. Second, the shared implicit perspective is conceptualized through continuous dialogue among members. Tacit field-specific perspectives are converted into explicit concepts that can be shared beyond the boundary of the community. It is a process in which one builds concepts in cooperation with others. It provides the opportunity for one's hypothesis or assumption to be tested. As Markova and Foppa (1990) argue, social intercourse is one of the most powerful media for verifying one's own ideas. Next come the step of justification, which determines the extent to which the knowledge created within the community is truly worthwhile for the organization (or rather the specific discipline). Typically, an individual justifies the truthfulness of his or her beliefs based on observations of the situation; these observations, in turn, depend on a unique viewpoint, personal sensibility, and individual experience. Accordingly, when someone creates knowledge, he or she makes sense out of a new situation by holding justified beliefs and committing to them. Indeed, the creation of knowledge, from this angle, is not simply a compilation of facts but a uniquely human process that cannot be reduced or easily replicated. It can involve feelings and belief systems of which we may not even be conscious. Nevertheless, justification must involve the evaluation standards for judging truthfulness. There might also be value premises that transcend factual or pragmatic considerations. Finally, we arrive at the stage of cross-leveling knowledge (Nonaka, 2002). During this stage, the concept that has been created and justified is integrated into the knowledge base of the community, which comprises a whole network of organizational knowledge.

DEFINING THE SOCIO-TECHNICAL APPROACH FOR DESIGNING REALSPACE

The use of the term *socio-technical* refers to the interrelatedness of *social* and *technical* aspects of an organization, carrying with it two important connotations (Wikipedia, 2008). The first is that the interaction of social and technical factors creates the conditions for successful (or unsuccessful) organizational performance. This interaction is comprised partly of linear cause-and-effect relationships (the relationships that are normally designed) and partly from non-linear, complex, even unpredictable relationships (the good or bad relationships that are often unexpected). Whether designed or not, both types of interaction occur when socio and technical elements are put to work. The corollary of this, and the second of the two connotations, is that optimization of each aspect alone (socio or technical) tends to increase not only the quantity of unpredictable, un-designed relationships, but those relationships that are injurious to the system's performance. Socio-technical theory therefore proposes a number of different ways of achieving joint optimization through which the relationships between socio and technical elements lead to the emergence of productivity and wellbeing in an organization. The term *socio-technical systems* coined in the 1960s by Eric Trist and Fred Emery, who were working as consultants at the Tavistock Institute in London, refers to an approach to complex organizational work design that recognizes the interaction between people and technology in workplaces. And socio-technical systems theory (Emery & Trist, 1960) is a theory about the social aspects of people and society and technical aspects of machines and technology. The idea of work (or job) design in organizational development is the application of **socio-technical systems** principles and techniques to the humanization of work, whose aims are to improve job satisfaction, to improve through-put, to improve quality and to reduce employee problems, e.g., grievances, absenteeism, and more importantly, in our context of *REALSpace*, to improve knowledge sharing. Thereby, by socio-technical approach, we mean there is an interdependent and reciprocal relationship between humans and technology; namely, both the social and the technological aspects of knowledge work need to be in harmony to increase effectiveness and to "humanize" the environment. Technically, this would be achieved mainly by user participation in the design of the system services and devices that users are to operate at the knowledge environment.

Accepting the Architecting Challenge of IS Support

Undeniably, setting up the information system (IS) support for various communities of learning (be it Web-based or not), is a social act in itself, requiring some kind of concerted action by many different people (Vat, 2005b); and the operation of any IS subsystem entails such human phenomena as attributing meaning to specific set of goal-related activities and making judgments about what constitutes a relevant category. Subsequently, our *REALSpace* is often seen at core as a conversational process in which the world is often interpreted in a particular way which legitimates shared actions and establishes shared norms and standards. There is no single body of work, which underlies this soft approach to IS, but the works of Sir Geoffrey Vickers (1965) provide quite an interesting reference. For Vickers, organizational members set standards or norms rather than goals, and the traditional focus on goals is replaced by one on managing relationships according to standards generated by previous history of the organization. Furthermore, the discussion and debate, which leads to action is one in which social action is based upon personal and collective sense making (Weick, 1995). Thereby, organizations are also regarded as networks of conversation or communicative exchanges in which commitments are generated (Ciborra, 1987; Winograd & Flores, 1986). And IS support should be thought of as making such exchanges easier – the exchange support systems. Thereby, a strategy for IS support needs to be thought of, through which desirable change and organizational learning are often considered as the ultimate ends. Its stages of development could be characterized as follows (Wilson, 2001) with plausible iterations in stages 3, 4, and 5: 1) define the situation that has provoked concerns; 2) express the situation with different sets of concerns; 3) select concepts that may be relevant; 4) assemble concepts into an intellectual structure; 5) use this structure to explore the situation; 6) define changes to the situation as the challenges to be explored; and 7) implement the change processes. Given the great variety of organizational design problems for CoL-based IS support, considerable flexibility must exist in the concepts and structures available to the analysts. It is believed that unless the peculiar methodology is assembled as a conscious part of the analysis, it is very unlikely that the changes and solutions identified will represent an effective output of the analysis. More importantly, the specific methodology needs to be explicit in order to provide a defensible audit trail from recommendations back to initial assumptions and judgments. Thereby, thinking about how to think in designing IS support is about planning the intellectual process to follow up with the design itself. And there are numerous challenges (Carroll, 1995; 2000) in the underlying process. First, there is often an incomplete description of the problem to be addressed, but it is always necessary to identify the relevant description of the current situation that is to be altered by the design work. Secondly, the problem space of allowable and possible moves is often not determined beforehand. In fact, there is often no guidance on possible design moves in reasoning from a description of the current situation toward an improved version of the situation. Thirdly, design problems themselves characteristically involve many trade-offs; any move creates side effects, such as impacts on human activities. Accordingly, it is by no means a routine process in the IS design for our organizational communities of learning involving both teachers and students.

Adopting the Scenario-Based Design Method

According to Checkland and Holwell (1995), the main role of an information system (IS) is that of a support function helping people in their purposeful actions. Many of today's information systems are found difficult to learn and awkward to use because they often change our activities in ways that we do not need or want. The problem lies in the IS development process. Oftentimes, IS designers have to face convoluted networks of trade-off and inter-dependence, the need to coordinate and integrate the contributions of many kinds of experts, and the potential of unintended impacts on people and their social institutions. Today, we need a more down-to-earth approach to IS development. Our experience has indicated that scenario-based design approach (Vat, 2005b; Carroll, 1995; 2000) turns out to be a pragmatic choice that seeks to exploit the complexity and fluidity of design by trying to learn more about the concrete elements of the problem situation. Thereby, John Carroll characterizes scenarios as concrete stories about use through which IS architects could envision and facilitate new ways of doing things and new things to do. Specifically, scenarios provide a vocabulary for coordinating the central tasks of systems development – understanding people's needs, envisioning new activities and technologies, designing effective systems and software, and drawing general lessons from systems as they are developed and used. Namely, scenarios help IS designers analyze the various possibilities by focusing first on the human activities that need to be supported and allowing descriptions of those activities to drive the quest for correct problem requirements. It is expected that through maintaining a continuous focus on situations of and consequences for human work and activities, IS designers could become more informed of the problem domains, seeing usage situations from different perspectives, and managing trade-offs to reach usable and effective design outcomes (Carroll, 1994; 1995).

Modeling Purposeful Human Activities

Consequently, through the appropriate use of design scenarios, the problem of designing CoL-based IS support for knowledge work (Vat, 2005a) should never be thought of as something to be defined once and for all, and then implemented. Instead, it must be based on the observation that all real-world organizational problem situations contain people interested in trying to take purposeful action (Checkland, 1999). Pragmatically, the idea of a set of activities linked together so that the whole, as an entity called the human activity system (HAS) from the viewpoint of Soft Systems Methodology (SSM) (Checkland & Holwell, 1998; Checkland & Scholes, 1999) could pursue a purpose, would indeed be considered as a representative organizational scenario for architecting IS support, which should never be fixed once and for all. In practice, given a handful of the HAS models, namely, models of concepts of purposeful activity built from a declared point of view, we could create a coherent structure to debate about the problem situation and what might improve it (Checkland, Forbes, & Martin, 1990; Checkland, 1983; Checkland, 1981). Subsequently, from the IS architect's point of view, while conceiving the necessary IS support to serve the specific organizational knowledge requirements, the fundamental ideas could be integrated as follows: Always start from a careful account of the purposeful activity to be served by the system. From that, work out what informational support is required (by people) to carry out the activity. Treat the creation of that support as a collaborative effort between technical experts and those who truly understand the purposeful action served. Meanwhile, ensure that both system creation and system development and use are treated as opportunities for continuous learning. In this way, models of purposeful human activities can be used as scenarios to initiate and structure sensible discussion about IS support for the people undertaking the real-world problem situations. Thereby, the process of IS development needs to start not with attention quickly focused on data and technology, but with a focus on the actions served by the intended IS system. Once the actions to be supported have been decided and described, which can usefully be done using activity models we can proceed to decide what kind of support should be provided. The key point is that in order to create the necessary IS support which serves the intended organizational scenario, it is first necessary to conceptualize the organizational system (different communities of learning) which is to be served, since this order of thinking should inform what relevant services would indeed be needed in the IS support.

CURRENT PROBLEMS FACING OUR WORK

Too often, software creation is viewed in engineering terms rather than as the cross-disciplinary process it should be perceived as. This claim should not be interpreted as anti-engineering; engineers (or developers) and stakeholders are essential allies and partners in software creation. But, they are not the only partners in the complex process of software creation. Many people and disciplines share equal footing. In socio-technical systems, software is understood as part of the final product. System requirements are captured to identify the functioning of the system, from which software requirements are derived. Deciding which functionality is implemented where, and by which means is a technical decision process in which feasibility, dependability, and economics play a role. A well structured and technically sound requirements management process for effective prototyping, is therefore of utmost importance. There are several challenges identified in this important process of ongoing system prototyping.

Eliciting Requirements from Various Sources

Requirements gathering starts with identifying the stakeholders of the system and collecting (or eliciting) raw requirements, which have not been analyzed and not yet been written down in a well-formed requirement notation, such as UML. Business requirements, customer requirements, user requirements, constraints, in-house ideas and standards are the different viewpoints to cover. Typically, specifying system requirements starts with observing and interviewing people (Ambler, 1998). This is indeed not a straightforward task, because users may not have the same usage (or use case) interpretation as the developers. Oftentimes, user requirements are misunderstood simply because the requirements collector misinterprets the users' ideas (or words).

Analyzing and Documenting Requirements

The gathering of requirements often reveals a large set of raw requirements that, owing to cost and time constraints, cannot entirely be prototyped in the system. Also, the identified raw requirements may be conflicting. Therefore, negotiation, agreement, communication, and priority-setting of the raw materials are also an important part of the requirements analysis process. The analyzed requirements need to be documented to enable communication with stakeholders and future maintenance of the requirements and the system (or prototype). Requirements documentation also includes describing the relations between requirements. During requirements analysis it gives added value to record the rationale behind the decisions made to ease future change management and decision making.

Validating and Verifying System Requirements

In system requirements development, validation and verification activities include validating the system requirements against raw requirements and verifying the correctness of system requirements documentation in an ongoing basis. Common techniques for validating requirements include reviews with the stakeholders and prototyping (Parviainen et al, 2005). Traditionally, requirements engineering is performed in the beginning of the system development lifecycle. However, in large and complex system development, developing an accurate set of requirements that would remain stable throughout the months or years of development has been realized to be impossible in practice (Dorfman, 1990). Validating and verifying system requirements is an incremental and iterative process, performed in parallel with other system development activities such as design.

Identifying a Community-Centered Prototyping Process

Nonetheless, building a virtual community is a fundamentally different activity from writing computer code (Vat, 2008b; Kollock & Smith, 1996). Online communities evolve organically, shaped by their members and leaders. The software supporting the online community and its early social policies also influences how it develops. As people become familiar with each other and leaders make decisions about how to direct the group, social policies may change. So, the relationship between the design of any software artifact, the way people use it, and how it both affects and is affected by social norms is complex. When the software is intended to support social interaction, understanding the community's needs and user tasks becomes very important. Prototyping for community-centered development must be participatory by design. It must focus on the community's needs prior to making decisions about the technology and social planning. According to Jenny Preece (2000, pp. 208), there are two main parts to the process: software selection and tailoring, and sociability planning. The former is concerned with the appropriateness of the software artifacts for community members' tasks and the community's purpose. The latter describes the appropriateness of the social policies and plans for guiding social interactions. Both are key components of successful online communities, and as development proceeds they invariably become more closely integrated. In fact, evaluating how well software design (selection and tailoring) and sociability planning meet the community's needs occurs continuously throughout the prototyping process. Prototyping proceeds iteratively, with many develop-and-test cycles, during which community members provide feedback and participate in the development themselves. Oftentimes, we need to apply techniques from user-centered design (Norman, 1986; Kreitzberg, 1998; Shneiderman, 1998; Preece et al, 2007), contextual inquiry (Beyer & Holtzblatt, 1998), as well as participatory design (Greenbaum & Kyng, 1991; Muller, 1992; Schuler & Namioka, 1993; Lazar & Preece, 1999).

REMARKS FOR CONTINUING CHALLENGE

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 advent of the Internet. 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 teacher's continual interventions.

Undoubtedly, it takes a certain amount of independence and determination to change the way one teaches. It also takes time and involves risks. Where do instructors acquire the commitment to get started with this change? Frequently, commitment grows out of the recurring frustration most instructors experience when they realize how little their students understand or remember from a semester of dedicated lectures. If not ignored, that frustration leads to reflection on what it means to teach and to learn. In this regard, student-centered design (in particular, problem-based learning, PBL) addresses these issues and offers an attractive alternative to traditional education by shifting the focus of education from what faculty teaches to what students learn. Content remains important, but emphasis shifts more to the process. Indeed, Greening (1998, 2000) describes PBL 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. Consequently, our creative knowledge environment embedded inside the *REALSpace* identifies with a learner-centered perspective of PBL based on the idea of collaborative learning, where it is necessary to clarify the new roles of the teachers and the students, in support of our virtual community of learners.

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 of PBL, 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.

A New Role of the Students

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.

CONCLUSION

What make the virtual community of learning work is 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. When a group of people, over time, have learned to enhance their capacity to create what they truly desire to create, this is an instance of a learning organization (Senge, 1990). Looking more closely at the generative potential of community development, we often see people being changed, somewhat profoundly. There is a deep learning cycle. Community members develop new skills and capabilities, which alter what they can do and understand. As new capabilities develop, so too do new awareness and sensibilities. Over time as people start to see and experience the world differently, new beliefs and assumptions should begin to form, which enables further development of skills and capabilities. This deep learning cycle constitutes the essence of our creative knowledge environment – the development not just of new capacities, but also of fundamental shifts of mind, individually and collectively (Senge, Roberts, Ross, Smith, and Kleiner, 1994). Today, an organization's ability to learn is often considered as a process of leveraging the collective individual learning of an organization to produce a higher-level organization-wide intellectual asset. This is a continuous process of creating, acquiring, and transferring knowledge accompanied by a modification of behavior to reflect new knowledge and insight, and to produce a higher-level organizational asset. Garvin (1993) characterizes organizational learning as a continual search for new ideas. The central belief behind the *REALSpace* project is assuming an organization of learners who take ownership for their development and learning on a self-directed basis. Yet, only with a clear understanding of some fundamental values (borrowed from Peter Senge's disciplines of learning organization – personal mastery, mental models, shared vision, team learning, and systems thinking) can we manage the knowledge processes consistent with our community of learning. Personal mastery is learning to expand our personal capacity to create the results we most desire, and it is about creating an organizational environment which encourages all its members to develop themselves toward the goals and purposes they choose. Mental models include the reflecting upon, continually clarifying, and improving our internal pictures of the world, and seeing how they shape our actions and decisions. Shared vision is concerned with building a sense of commitment in a group, by developing shared images of the future we seek to create, and the principles and guiding practices by which we hope to get there. Team learning is about transforming conversational and collective thinking skills, so that groups of people can reliably develop intelligence and ability greater than the sum of individual members' talents. Systems-thinking is concerned with cultivating a way of thinking about, and a language for describing and understanding, the forces and inter-relationships that shape the behavior of our systems (vitural communities). This discipline helps us see how to change systems more effectively and to act more in tune with the larger processes of the external world (related to individual student learner, teams of student members, course-specific community of learners, program-specific community of learners, and others). We truly identify with Peter Senge (1990) that the organizations that will truly excel in the future will be the organizations that discover how to tap people's commitment and capacity to learn at all levels in an organization. To harvest the knowledge and experience of people and make it available to the organization as a whole, our discussion of the ideas behind the *REALSpace* serves to present some of our current thinking and efforts to strive toward the goal of better education for our coming generations with better technological and pedagogical means.

REFERENCES

Albanese, M., & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine*, *68* (1): 52-81.

Amador, J.A., Miles L., & Peters, C.B. (2006). *The practice of problem-based learning: A guide to implementing PBL in the college classroom*. Bolton, Massachusetts: Anker Publishing Company, Inc.

Ambler, S.W. (1998). *Process patterns: Building large-scale systems using object technology.* Cambridge University Press.

Bangert, A. (2004). The seven principles of good practice: A framework for evaluating online teaching. *The Internet and Higher Education*, 7(3), 217-232.

Barrows, H.S. (1985). *How to design a problem-based curriculum for the pre-clinical Years*. New York, Springer.

Barrows, H.S. (1986). A taxonomy of problem-based learning methods, *Medical Education*, 20: 481-486.

Barrows, H.S. (1988). *The tutorial process*. Illinois: Southern Illinois University School of Medicine.

Bates, A.W. (1995). *Technology, open learning and distance education.* London: Routledge.

Batson, T. (2005). The electronic portfolio boom: what's it all about? *Campus Technology.* Available online at: http://www.campustechnology.com/article.asp?id=6984 (last accessed 2008-May-10).

Beyer, H. & Holtzblatt, K. (1998). *Contextual design: Defining customer-centered systems*. San Francisco, CA: Morgan Kaufmann Publishers, Inc.

Bonk, C., Medury, P., & Reynolds, T. (1994). Cooperative hypermedia: The marriage of collaborative writing and mediated environments. *Computers in the Schools*, 10 (1 & 2): 79-124.

Bonk, C. & Reynolds, T. (1997). Learner-centered Web instruction for higher-order thinking, teamwork, and apprenticeship. In B.H. Kahn (Ed.), *Web-based Instruction* (pp. 167-178). Englewood cliffs: Educational Technology Publications.

Booth, S. (2001). Learning computer science and engineering in context. *Computer Science Education, 11* (3): 169-188.

Boss, S., & Krauss, J. (2007). *Reinventing project-based learning: Your field guide to real-world projects in the digital age*. Washington, D.C.: International Society for Technology in Education (ISTE).

Boud, D. (ed.) (1985). *Problem-based learning in education for the professions*. Sydney: HERDSA.

Boud, D., & Feletti, G. (1997). The challenge of problem-based learning (2nd ed.). London: Kogan Page.

Boyer Commission on Educating Undergraduates in the Research University for the Carnegie Foundation for the Advancement of Teaching. (1998). *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*. URL Last accessed on May 10, 2008: http://naples.cc.sunysb.edu/Pres/boyer.nsf.

Boyle, T. (1997). *Design for multimedia learning* (pp. 107-109). Prentice Hall Europe.

Bresciani, M. (2006). *Outcomes-based academic and co-curricular program review: A compilation of institutional good practices*. Sterling, VA: Stylus Publishing.

Brown, A.L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences, 2* (2), pp. 141-178.

Brown, A.L., Ash, D., Rutherford, M., Nakagawa, K., Gordon, A., & Campione, J.C. (1993). Distributed expertise in the classroom. In G. Salomon (Ed.), *Distributed cognitions: Psychological and educational considerations* (pp. 188-228). New York: Cambridge University Press.

Bruer, J.T. (1993). *Schools for thought.* Cambridge, MA, MIT Press.

Budd, A., Collison, S., Heilemann, M., et al. (2006). *Blog Design Solutions*. New York: friendsof.

Carroll, J.M., (1994). Making use a design representation. *Communications of the ACM*, *37*(12), 29-35.

Carroll, J.M., (2000). *Making use: Scenario-based design of human-computer interactions.* Cambridge, MA: MIT Press.

Carroll, J.M., (ed.), (1995). *Scenario-based design: Envisioning work and technology in system development*. New York: John Wiley & Sons.

Checkland, P. (1983). Information systems and systems thinking: Time to unite? *International Journal of Information Management,* 8, 230-248.

Checkland, P. & S. Holwell, (1995). Information systems: What's the big idea? *Systemist*, *17*(1), 7-13.

Checkland, P. & Holwell, S. (1998). *Information, systems, and information systems: Making sense of the field.* Chichester: John Wiley and Sons.

Checkland, P. & J. Scholes, (1999). *Soft systems methodology in action.* Chichester: Wiley.

Checkland, P. (1999). Systems thinking. In W.L. Currie, and B. Galliers (eds.), *Rethinking Management Information Systems*. Oxford University Press.

Checkland, P. (1981). *Systems thinking, systems practice.* Chichester: Wiley.

Checkland, P., Forbes, P., & Martin, S. (1990). Techniques in soft systems practice, part 3: Monitoring and control in conceptual models and in evaluation studies. *Journal of Applied Systems Analysis*, *17*, pp. 29-37.

Choate, M.S. (2008). *Professional Wikis*. Indianapolis: Wiley Publishing, Inc.

Chung, J. (1991). Collaborative learning strategies: The design of instructional environments for the emerging new school. *Educational Technology, 31* (12): 15-22.

Ciborra, C.U. (1987). Research agenda for a transaction costs approach to information systems. In Boland and Hirschheim (eds). *Critical Issues in Information Systems Research.* Chichester: John Wiley and Sons.

Cobb, P. & Yackel, E. (1996). Constructivist, emergent, and socio-cultural perspectives in the context of developmental research. *Educational Psychologist*, *31* (3/4): 175-190.

Collins, A., Brown, J.S. & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L.B. Resnick (Ed.) *Cognition and instruction: Issues and agendas*. Lawrence Erlbaum Associates.

Cuthbert, A., Clark, D., Slotta, J., & Jorde, D. (2000). *Helping elicit self-explanation and clarification through personalized electronic discussions.* Paper presented at Annual Meeting of the America Research Association (AERA), New Orleans, USA.

DiBiase, D. with contributions by Zembal-Saul, C., Sabre, J., Howard, D., Rademacher, H., Burlingame, P., Melander, G., Schall, J., Spielvogel, E., Mathews, J., & Orndorff, R. (2002). *Using e-Portfolio at Penn State to enhance student learning: Status, prospects and strategies*. E-education Institute, The Pennsylvania State University. Available online at: https://www.e-education.psu.edu/files/e-port_report.pdfl (Last accessed on May 11, 2008).

Dierkes, M., Marz, L. and Teele, C. (2001). Technological visions, technological development, and organizational learning. In M. Dierkes, A.B. Antal, et al. (Eds.), *Handbook of organizational learning and knowledge* (pp.282-304). Oxford University Press.

Dilworth, R.L. (1998). Action learning in a nutshell. *PIQ*, *11* (1): 28-43.

Dorfman, M. (1990). System and software requirements engineering. In R.H. Thayer & M. Dorfman (Eds.), *IEEE system and software requirements engineering, IEEE software tutorial*. Los Alamos, CA: IEEE Computer Society Press.

Duch, B.J., Grob, S.E., & Allen, D.E. (Eds.) (2001). *The power of problem-based learning: A practical "How To" for teaching undergraduate course in any discipline.* Sterling, VA: Stylus Publishing, LLC.

Duffy, T.M. & Cunningham, D.J. (1996). Constructivism: Implications for the design and delivery of instruction. In D.H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170-198). New York: Macmillan.

Eklund, J., Kay, M. & Lynch, H. (2003). E-learning: Emerging issues and key trends. *Australian Flexible Learning Framework* discussion paper. Available online at http://www.flexiblelearning.net.au (last accessed on May 10, 2008).

Emery, F.E., & Trist, E.L. (1960). Sociotechnical systems. In C.W. Churchman & M. Verhulst (Eds.), *Management sciences: Models and techniques* (Vol. 2. pp. 83-97). Pergamon Press.

Ertl, B., Winkler, K., & Mandl, H. (2007). E-Learning: Trends and future development. In F.M.Neto and F.V. Brasileiro (Eds.), *Advances in computer-supported learning* (pp. 122-144). Hershey: Information Science Publishing.

Evensen, D.H., & Hmelo, C.E. (2000). *Problem-based learning: A research perspective on learning interactions*. Mahwah, NJ: Lawrence Erlbaum Associates.

Fabos, B. & Young, M. (1999). Telecommunications in the classroom: Rhetoric versus reality. *Review of Educational Research*, 69 (3): 217-259.

Garvin, D.A. (1993). Building a learning organization. *Harvard Business Review*, *71* (4): 78-91.

Grabinger, R.S. & Dunlap, J.C. (1995). Rich environments for active learning: A definition, *ALT-J Association for Learning Technology Journal*, 3 (2): 5-34.

Grabinger, S. & Dunlap, J.C.(1996). Encourage student responsibility. In Piet A.M. Kommers, S. Grabinger, and J.C. Dunlap (Eds.), *Hypermedia learning environments: Instructional design and integration*. Lawrence Erlbaum Associates.

Greenbaum, J. & Kyng, M.E. (1991). *Design at work: Cooperative design of computer systems*. Hillsdale, NJ: Lawrence Erlbaum.

Greening, T. (2000). Emerging constructivist forces in computer science education: Shaping a new future? In T. Greening (ed.), *Computer science education in the 21st century* (pp. 47-80), Springer.

Greening, T. (1998). Scaffolding for success in problem-based learning. *Medical Education Online*, *3*(4): 1-15.

Grunert, J. (1997). *The course syllabus: A learning-centered approach*. Bolton, Massachusetts: Anker Publishing Company, Inc.

Guzdial, M., Kolodner, C., Hmelo, C., Narayanan, H., Carlson, D., Rappin, N., Hubscher, R., Turns, J., & Newsletter, W. (1996). Computer support for learning through complex problem solving. *Comm. ACM* 39, 4 (April), pp.43-45.

Hemlin, S., Allwood, C.M., & Martin, B.R. (2004). *Creative Knowledge Environments: The influences on creativity in research and innovation*. Northampton, MA, USA: Edward Elgar.

Holzner, S. (2006). *Secrets of RSS: A guided tour of the mysteries of RSS for both readers and publishers*. Berkeley, CA: Peachpit Press.

Honebein, P.C., Duffy, T.M., & Fishman, B.J. (1993). Constructivism and the design of authentic learning environments: Context and authentic activities for learning. In T.M. Duffy, J.Lowyck, & D.H. Jonassen (Eds.), *Designing environments for constructive learning* (pp. 87-108). Berlin: Springer-Verlag.

Jafari, A. & Kaufman, C. (2006). *Handbook of research on ePortfolios*. Hershey: Idea Group Reference.

Kim, D. (1993). The link between individual and organizational learning. *Sloan Management Review*, (Fall), pp. 37-50.

King, K.P., & Gura, M. (2007). *Podcasting for teachers: Using a new technology to revolutionize teaching and learning.* Charlotte, NC: Information Age Publishing, Inc.

Kollock, P. & Smith, M. (1996). Managing the virtual commons: Cooperation and conflict in computer communities. In S. Herring (Ed.), *Computer-mediated communication: Linguistic, social, and cross-cultural perspectives*. Amsterdam: John Benjamins.

Kreitzberg, C. (1998). *The LUCID Design Framework (Logical User-Centered Interaction Design)*. Princeton, NJ: Cognetics Corporation.

Land, F. (1985). Is an information theory enough? *The Computer Journal,* 28(3), 211-215.

Laurillard, D. (1993). *Rethinking university teaching: A framework for the effective use of educational technology*. Routledge.

Lazar, J. & Preece, J. (1998). Classification schema for online communities. Paper presented at the 1998 Association for Information Systems, Americas Conference.

Lazar, J., & Preece, J. (1999). Implementing service learning in an online communities course. Paper presented at the Proceedings of the 1999 Conference of the International Association for Information Management, 22-27.

Leonard-Barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation.* Boston: Harvard Business School Press.

Leuf, B., & Cunningham, W. (2001). *The Wiki way: Quick collaboration on the Web*. New York: Addison Wesley.

Levene, M. (2006). *An introduction to search engines and Web navigation*. Harlow, UK: Addison Wesley.

Linn, M.C., & Hsi, S. (2000). *Computers, teachers, peers: Science learning partners.* Mahwah, NJ: Lawrence Erlbaum.

Littlejohn, A., & Pegler, Chris (2007). *Preparing for blended e-Learning*. New York: Routledge.

Lorenzo, G., & Ittelson, J. (2005). An overview of institutional e-portfolios. In D. Oblinger (Ed.), *Educause learning initiative*. Available online at:

http://www.educause.edu/ir/library/pdf/ELI3002.pdf (last accessed May 10, 2008).

Margetson, D. (1994). Current educational reform and the significance of problem-based learning. *Studies in Higher Education, 19*: 5-19.

Markova, I. & Foppa, K. (Eds.) (1990). *The dynamic of dialogue*. New York: Harvester Wheatsheaf.

Marshall, H. (1996). Recent and emerging theoretical frameworks for research on classroom learning: Contributions and limitations. *Educational Psychologist, 31* (3/4): 147-244.

Mayer, R.E. (1988). Learning strategies: An overview. In C. Weinstein, E.T. Goetz, and P.A. Alexander (Eds.), *Learning and study strategies* (pp. 11-22). New York: Academic Press.

Muller, M.J. (1992). Retrospective on a year of participatory design using the PICTIVE technique. Paper presented at the Proceedings CHI'92 Human Factors in Computing Systems, Monterey, CA.

Neto, F.M., & Brasileiro, F.V. (2007). *Advances in computer-supported learning*. Hershey: Information Science Publishing.

Neufeld, V., & Barrows, H. (1974). The McMaster philosophy: An approach to medical education. *Journal of Medical Education, 49:* 1040-1050.

Nonaka, I. (2002). A dynamic theory of organizational knowledge creation. In C.W. Choo, and N. Bontis (Eds.), *The Strategic Management of Intellectual Capital and Organizational Knowledge* (pp. 437-462). Oxford University Press.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge creating company: How Japanese companies create the dynamics of innovation.* Oxford University Press.

Norman, D.A. (1986). Cognitive engineering. In D. Norman & S. Draper (Eds.), *User-Centered Systems Design*. Hillsdale, NJ: Lawrence Erlbaum.

O'Connor, M.C. (1998). Can we trace the efficacy of social constructivism? In P.D. Pearson and A. Iran-Nejad (Eds.), *Review of research in education*, 23: 25-71.

O'Donnell, J.M., & Caffarella, R.S. (1990). Learning contracts. In M.W. Galbraith (Ed.), *Adult learning methods* (pp.133-160). Malabar, Florida: Krieger Publishing Company.

Parviainen, P., Tihinen, M., Lormans, M., & van Solingen, R. (2005). Requirements engineering: Dealing with the complexity of sociotechnical systems development. In J.L. Mate and A. Silva (Eds.), *Requirements Engineering for Sociotechnical systems.* Hershey: Information Science Publishing.

Perkins, D.N. (1991). Technology meets constructivism: Do they make a marriage? *Educational Technology*, *31*(5): 18-23.

Piaget, J. (1952). *The origins of intelligence in children*. New York: Norton.

Preece, J. (2000). *Online communities: Designing usability, supporting sociability.* Chichester: John Wiley & Sons, Ltd.

Preece, J., Rogers, Y., & Sharp, H. (2007). *Interaction design: Beyond human-computer interaction, 2nd edition*. New York, NY: John Wiley & Sons, Inc.

Rennie, F., & Mason, R. (2004). *The connection: Learning for the connected generation*. Charlotte, NC: Information Age Publishing.

Richardson, W. (2006). *Blogs, wikis, podcasts, and other powerful Web tools for classroom*. Thousand Oaks, CA: Corwin Press.

Ryan, G. (1993). Student perceptions about self-directed learning in a professional course implementing problem-based learning. *Studies in Higher Education*, *18*: 53-63.

Salomon, G. & Perkins, D.N. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. *Educational Psychologist, 24* (2): 112-132.

Savery, J.R., & Duffy, T.M. (1995). Problem-based learning: An instructional model and its constructivist framework. *Educational Technology*, *35* (5): 31-38.

Savory, P., Burnett, A.N., & Goodburn, A. (2007). *Inquiry into the college classroom: A journey toward scholarly teaching*. Bolton, Massachusetts: Anker Publishing Company, Inc.

Scardamalia, M., Bereiter, C., McLean, R.S., Swallow, J. & Woodruff, E. (1989). Computer-supported intentional learning environments. *Journal of Educational Computing Research*, 5(1): 51-68.

Schrage, M. (1990). *Shared minds*. New York: Random House.

Schuler, D., & Namioka, A.E. (1993). *Participatory design: Principles and practices*. Mahwah, NJ: Lawrence Erlbaum.

Senge, P. (1990). *The fifth discipline: The art and practice of the learning organization.* London: Currency Doubleday.

Senge, P.M., Roberts, C., Ross, R.B., Smith, B.J. & Kleiner, A. (1994): *The fifth discipline fieldbook: Strategies and tools for building a learning organization.* N.Y., Currency Doubleday.

Shneiderman, B. (1998). *Designing the user interface: Strategies for effective human-computer interaction. (Third edition)*. Reading, MA: Addison-Wesley.

Slavin, R. (1994). Student teams and achievement divisions. In S. Sharon (Ed.), *Handbook of cooperative learning methods.* Westport, CT: Greenwoeed Press, pp. 3-19.

Squires, D. (1999). Educational software for constructivist learning environments: Subversive use and volatile design. *Educational Technology*, 39 (3): 48-54.

Stacey, E. (1998). Learning collaboratively in a CMC environment. In G. Davies (Ed.) *Teleteaching 98: Distance Learning, Training and Education*, *Proceedings of the XV IFIP World Computer Congress*, pp. 951-960, Vienna and Budapest.

Stefani, L., Mason R., & Pegler, C. (2007). *The educational potential of e-portfolios: Supporting personal development and reflective learning*. New York: Routledge.

Stopford, John, M. (2001). Organizational learning as guided responses to market signals. In M. Dierkes, A.B. Antal, et al. (eds.), *Handbook of organizational learning and knowledge* (pp. 264-281). Oxford University Press.

Su, B., Bonk, C., Magjuka, R., Liu, X., & Lee, S.H. (2005). The importance of interaction in Web-based education: A program-level case study of online MBA courses. *Journal of Interactive Online Learning, 4* (1), 1-19. Available online at: http://www.ncolr.org/jiol/issues/PDF/4.1.1.pdf (last accessed on May 10, 2008).

Vat, K.H. (2008a). An ePortfolio scheme of flexible online learning. To appear in Patricia L. Rogers, C. Howard, J. Boettcher, L. Justice, K. Schenk, and G.A. Berg (Eds.), *Encyclopedia of Distance and Online Learning, 2nd Edition*. Hershey: Information Science Reference.

Vat, K.H. (2008b). Building virtual communities through a de-marginalized view of knowledge networking. In Jerzy Kisielnicki (Ed.), *Virtual Technologies: Concepts, Methodologies, Tools, and Applications (3 Volumnes)* (pp. 488-502). Hershey, PA: Information Science Reference.

Vat, K.H. (2007). Conceiving a learning organization model for online education. In Lawrence A. Tomei (Ed.), *Online and distance learning: Concepts, methodologies, tools, and applications (6 Volumes)* (pp. 1128-1136). Hershey, PA: Information Science Reference.

Vat, K.H. (2006a). Developing a learning organization model for problem-based learning: The emergent lesson of education from the IT trenches. In *Journal of Cases on Information Technology*, Volume 8, Number 2, April-June, pp. 82-109.

Vat, K.H. (2002). Developing learning organization strategy for online education: A knowledge perspective. In Proceedings of the *Fifth Annual Conference of the Southern Association for Information Systems (SAIS2002)*, Savannah, Georgia, USA: Southern Association for Information Systems, Mar. 1-2, pp. 291-298.

Vat, K.H. (2008c). ePortfolio and pedagogical change for virtual university. In G. D. Putnik & M. M. Cunha (Eds.), *Encyclopedia of Networked and Virtual Organizations* (pp.508-515). Hershey, PA: Information Science Reference.

Vat, K.H. (2006b). Integrating industrial practices in software development through scenario-based design of PBL activities: A pedagogical re-organization perspective. In *Journal of Issues in Informing Science and Information Technology*, Vol. 3 (June): 687-708.

Vat, K.H. (2006c). IS design for community of practice's knowledge challenge. In *E. Coakes and S.A. Clarke (Eds.), Encyclopedia of Communities of Practice in Information* *and Knowledge Management* (pp. 246-256). Hershey: Idea Group Reference.

Vat, K.H. (2000). Online education: A learner-centred model with constructivism. In Proceedings of the *Eighth International Conference on Computers in Education (ICCE 2000)*, Taipei, Taiwan, Nov. 21-24, pp. 560-568.

Vat, K.H. (2001a). REAL: Towards a WWW-enabled course support environment for active learning. In the *International Conference on Learning and Teaching Online (LTOL2001)*, Guangzhou, China: South China Normal University, Jan. 10-12, Paper No. 291.

Vat, K.H. (2005a). SSM-Based IS support for online learning. In C. Howard, J. Boettcher, L. Justice, K. Schenk, and G.A. Berg (Eds.), Vol. 4 of 4, *Online Learning and Technologies*, *Encyclopedia of Distance Learnin*g (pp.1650-1659). Hershey, PA: Idea Group Reference.

Vat, K.H. (2005b). Systems architecting of IS support for learning organizations: The scenario-based design challenge in human activity systems. In *Information Systems Education Journal*, Volume 3, Number 2, July (http://isedj.org/3/2/).

Vat, K.H. (2004a). Towards a learning organization model for PBL: A virtual organizing scenario of knowledge synthesis. CD-Proceedings of the *Seventh Annual Conference of the Southern Association for Information Systems (SAIS2004)*, Savannah, Georgia, USA, Feb. 27-28.

Vat, K.H. (2004b). Toward a learning organization model for student empowerment: A teacher-designer's experience as a coach by the side. In *Proceedings of the 2004 IADIS International Conference on Cognition and Exploratory Learning in Digital Age* (pp.131-140), Dec. 15-17, Lisbon, Portugal.

Vat, K.H. (2003). Toward an actionable framework of knowledge synthesis in the pursuit of learning organization. CD-Proceedings of the *2003 Informing Science + IT Education Conference (IsITE2003)*, Pori, Finland, Jun. 24-27.

Vat, K.H. (2006d). Virtual organizing online communities in support of knowledge synthesis. In S. Dasgupta (Ed.), *Encyclopedia of virtual communities and technologies* (pp. 547-555). Hershey, PA: Idea Group Reference.

Vat, K.H. (2001b). Web-based asynchronous support for collaborative learning. *Journal of Computing in Small Colleges* (Official Publication of Consortium for Computing in Small Colleges, CCSC), 17(2), December, pp. 310-328.

Vaughan, Tay (1994). *Multimedia: Making it work*, 2nd edition. Osborne: McGraw-Hill.

Vickers, G. (1972). Communication and appreciation. In Adams et al (Eds.), *Policymaking, Communication and Social Learning: Essays of Sir Geoffrey Vickers*. New Brunswick, NJ, USA.: Transaction Books.

Vickers, G. (1965). *The art of judgmen*t. London: Chapman and Hall.

Von Oech, R. (1986). *A kick in the seat of the pants*. New York: Harper & Row.

Vossen G., & Hagemann, S. (2007). *Unleashing Web 2.0: From concepts to creativity*. New York: Morgan Kaufmann.

Vygotsky, L.S. (1978). *Mind in society*. Cambridge MA: Harvard University Press.

Wehlburg, C.M. (2006). *Meaningful course Revision: Enhancing academic engagement using student learning data.* Bolton, Massachusetts: Anker Publishing Company, Inc.

Weick, K.E. (1995). *Sense-making in organizations*. Thousand Oaks, CA: Sage Publications.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W.M. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Harvard Business School Press.

Whipple, W.R. (1987). *Collaborative learning: Recognizing it when we see i*t. AAHE Bulletin, Vol. 4-6 (ERIC Documentation Reproduction Service No. ED289396).

Wikipedia (2008). Last accessed on May 10, 2008. Available online at: http://en.wikipedia.org/wiki/Sociotechnical_systems_theory.

Wilson, B. (2001). *Soft Systems Methodology: Conceptual Model Building and its Contribution*. John Wiley & Sons, Ltd, New York.

Wingspread Conference. (1994). Quality Assurance in Undergraduate Education: What the Public Expects. Denver, CO: Education Commision of the States.

Winograd, T. & Flores, F. (1986). *Understanding computers and cognition: A new foundation for design*. Reading, Mass.: Addison-Wesley.

Woods, D. (1994). How to gain the most from problem-based learning. McMaster: McMaster University.

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