SSM-Based IS Support for Online Learning

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INTRODUCTION

Imagine attending a class where the instructor, after giving an introduction of what the course is entailed, invites you to visit the Web-based course support environment (Vat, 2001). On entering the online environment, you are offered the privilege of creating your own personal space in the form of a customizable information system (IS), guarded by your personal self-assigned identifier and password. Within the personal electronic space, you are furnished with a whole set of tools to experience your learning in the subsequent course enactment (Vat, 2000). Perhaps, you may discover that this support environment is just one of the many environments available for each course offered. Indeed, each such environment is embedded inside the course organizational space, and your personal space is designed such that once inside your own electronic space, you can manage as many courses as you want. Your personal space is like your private workspace, in which you have to perform, keep track of and manage your learning activities. More excitingly, you are given the opportunity to participate in teamwork in the course you are enrolled. This is demonstrated by the provision of possible group spaces associated with the course. Each group space is often called the course collaborative space. Consequently, in your personal space, you can have access to many course organizational spaces, and the respective collaborative spaces installed for such courses (Vat, 2004). Let us further assume that group-based project work is considered as an essential component of the course you are taking. And your instructor has just uploaded the latest information on problem-based learning (PBL) to the course organizational space for your first research assignment. Thereby, it should be worthwhile to begin exploring the context behind the IS support (Vat, 2002a, 2002b), which aims to develop in the learners their abilities to learn, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use and construct knowledge in such an environment.

THE BACKGROUND OF CONSTRUCTIVIST CONCERNS

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 assigned to academic learning ever gets applied to actual scenarios, when there is such a rapid surge in knowledge commonly associated with the birth of the Internet age. This is a transference problem. Actually, the content product of learning is assuming a less-important role relative to the process of learning as the life of information content shortens and the need for continual learning increases. Relatively recent discussions in the literature (Cobb & Yackel, 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, Nakagawa, Gordon, & Campione, 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 & Reynolds, 1994;

Bonk & Reynolds, 1997; Fabos & Young, 1999). These communities open opportunities for learners to interact with multiple perspectives that challenge their existing knowledge constructions and impose cognitive conflicts (Piaget, 1952) requiring negotiations.

Our literature review also indicates that PBL, considered as an instance of the constructivist pedagogy, represents a promising relief from the instructivist tradition. Greening (1998) describes it as a vehicle for encouraging student ownership of the learning environment. There is an emphasis on contextualization of the learning scenario, providing a basis for later transference, and learning is accomplished by reflection as an important meta-cognitive exercise. Besides, the execution of PBL, often done via group-based project work, reflects the constructivist focus on the value of negotiated meaning. More importantly, PBL is not confined by discipline boundaries, encouraging an integrative approach to learning based on requirements of the problem as perceived by the learners themselves.

THE LEARNING CONTEXT FOR IS DESIGN

Although, as demonstrated in numerous studies (Evensen & Hmelo, 2000), PBL is the kind of group-based project work recognized as having many educational and social benefits – in particular, providing students with opportunities for active learning – it is our experience that teaching, directing and managing such project work is not at all an easy process. PBL projects demand considerable supervision and technical resources, and the process must combine design, human communications, human-computer interaction and technology to satisfy objectives ranging from consolidation of technical skills through provoking insight into organizational practice, teamwork and professional issues, to inculcating academic discipline and presentation skills.

In preparing students to get started with group-based project work, we need the kind of course support whose characteristics must be delineated and thoughtfully designed in a practical learning scenario to stimulate any learner-centered involvements. Our discussion renders some perspectives behind providing such course support, through describing the idea in setting up a Center for PBL Support whose operations are to be realized through the appropriate design of IS support (Kimball, 1995) for the communities of both the students and the instructors, respectively.

The PBL Paradigm of Investigation

PBL, according to Bruer (1993) and 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. At the heart of PBL is a set of group-based activities, including climate setting, starting a problem, following up the problem and reflecting on the problem (Barrows, 1985, 1988). A brief description of the PBL model of investigation is presented below.

The Climate Setting Phase

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

The Problem Initiation Phase

The actual PBL episode begins by presenting a group of students with minimal information about a particular problem. The students then query the given materials to determine what information is available and what they still need to know and learn to solve the problem. During this phase, students typically take on specific roles. An example is the scribe, who records the group's problem solving, including listing the facts known about the problem, students' ideas, additional questions about the problem and the learning issues generated throughout ensuing discussion. Such written record helps the students keep track of their problem solving and provides a focus for negotiation and reflection. Throughout the problem-solving process, students are encouraged to pause to reflect on the data collected, generating additional questions about that data, and hypothesizing about the problem and possible solutions. Early in the PBL process, the facilitator (instructor) may question students to help them realize what they do not understand. As students become more experienced with the PBL method and take on more of the responsibility for identifying learning issues, the facilitator is able to fade this type of support, or scaffolding. After the group has developed its initial understanding of the problem, the students divide up and independently research the learning issues they have identified. The learning issues define the group's learning goals and help group-members work toward a set of shared objectives. These objectives can also help the facilitator monitor the group's progress and remind members when they are getting off course or, alternately, to ask if they need to revise their goals.

The Problem Follow-Up Phase

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

The Problem Reflection Phase

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

The Mission of the Center for PBL Support

Under the auspices of an evolutionary process of institutional innovation, let us assume that our PBL initiative has been given a happy chance to develop in the form of the *Center for PBL Support* (*Center*, for short) (Vat, 2004). It is the *Center*'s commitment to blend the best of old values of good teaching with PBL and technologies so that we can extend our already unique curriculum and instructional practice over the Internet. The most important mission of this *Center* is to re-engineer most of our undergraduate courses for the PBL initiative. To learner-centered teachers, this means adopting a new philosophy of good instruction to encourage self-direction and learner control in their students. Thereby, the root concepts of learning support provided by the *Center* could be formulated along three important lines of thought:

1) **Enable students to determine what they need to learn through questioning and goal setting:** It is believed that students should work to identify their knowledge and skill deficits, and to develop strategies in the form of personal learning goals for meeting those deficits. The emphasis is to foster a sense of students' ownership in the learning process. If teachers, through the Web-based support environment, can guide the students in identifying what they already know and what they need to learn, then knowledge gaps and mistakes can be viewed in a positive way, such as another opportunity to learn. And, students can assume more responsibility in addressing their own learning needs during any instructional unit.
2) **Enable students to manage their own learning activities:** It is believed that students should be enabled to develop their learning plans, which should describe priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations and proposed learning outcomes, including presentation and dissemination of new knowledge and

skills, if applicable. Traditionally, these instructional events are arranged by teachers to be obeyed by students in order to accomplish a specified set of pre-determined objectives. Yet, it is not advantageous for students to learn to be self-directed. To manage their own learning activities, students must be guided and supported by the teacher through the Web-based environment, slowly taking on more and more responsibility of their own learning.

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

Undeniably, it is worthwhile for the *Center* to produce PBL project cases in terms of course reports for curriculum development and evaluation, and to manage the accrued knowledge resources of both teachers and students in terms of their contributions into the course support environment. It is understood that implementation success for the *Center* requires many ingredients: administrative vision and courage; the momentum and insight that comes from previous experience; a sound research-based educational framework to motivate educational change; extensive experience with the design, development and use of computer-related and networked educational tools and environments; a robust technical infrastructure and with high availability to all instructors and students; a culture that rewards innovation and quality in teaching; a strategy for instructor engagement and commitment for change; and more importantly, sufficient support in the leadership positions.

THE APPROACH OF IS ARCHITECTING

It is designed (Vat, 2004) that a Web portal is needed for the *Center* as an organizational unit. This portal should lead to a Web-based organizational space for the *Center*. Such an organizational space should be created to render a number of services to people with specific organizational roles (such as teacher and student) to accomplish their tasks (Bates, 1995), be they allocated along the function lines, process lines or workgroup lines. These services are then the potential candidates for distributed applications to be architected, and such services are often conceived according to the mission of the *Center*. In the context of the IS support, we should expect the organizational space is where people with different roles will come to electronically attend to their tasks, with the specific distributed applications provided. A simple expression of the organizational space (OS) for the *Center* could then be written as:

$$\mathrm{OS}_{Center} = \mathrm{SOS}_{Function} + \mathrm{SOS}_{Process} + \mathrm{SOS}_{Workgroup}$$

This expression is interpreted literally as follows: the organizational space for the *Centre* is composed of several sub-organizational spaces (SOS) for each of the three organizing constructs – function, process and workgroup – typically affiliated with an organizational unit (Berreman, 1997). For each of the organizing constructs, a number of distributed applications (DA) are to be conceived to provide services for accomplishing the tasks involved. Likewise, we can further express individual SOS as follows:

$$\mathrm{SOS} = \{\ DA_i\ \} \text{ for } i = 0, 1, 2, 3, \ldots$$

For completeness' sake, there should also be a Web-based role space (RS) embedded in the *Center's* organizational space for personnel with a specific role to embark so as to attend to his or her tasks through the provision of some distributed applications. Also, there could be links from the individual role space to the sub-organizational spaces. Hence, we could add the following expression:

$$\mathrm{RS}_{Individual} = \{\ DA_i\ \} + \text{Linking } [\mathrm{SOS}_{Function} + \mathrm{SOS}_{Process} + \mathrm{SOS}_{Workgroup}\ ] \text{ with } i = 0, 1, 2, 3, \ldots$$

Consequently, it is envisioned that in a specific course context, the interactions among students and between the instructor and students, enabled through the *Center*'s services, could be offered in a customizable way. First, there should be an organizational space for the course, OS_{Course}, to start with. Second, in the course space, there should also be a number of collaborative spaces, CS_{PBL}, to enable group-based project work to be performed by PBL students. Third, each student or teacher will be given a personal space, $PS_{\text{Individual}}$ (PS_{Teacher} or PS_{Student}), to facilitate individual work performance. The linkages from the course space to the respective collaborative spaces to the individual personal spaces must be closely constructed to facilitate the Web-based auxiliary experience of the teaching and learning processes. The challenge is to ensure that the sites should complement the course delivery by enabling both teacher and students to interact asynchronously or synchronously through the different customizable services offered. The simple expression for this vector could be written as follows: $\langle \text{IS Support} \rangle_{\text{Course}} = OS_{\text{Course}} + \{ CS_{\text{PBL}} \} + \{ PS_{\text{Student}} \} + PS_{\text{Teacher}}$. It should be noted that the community of student learners made up of different PBL groups is expected to form some virtual community of learners through the provision of the collaborative spaces in the course space.

The Instillation of Purposeful Action

One of the emphases in PBL teaching is that we learn by dealing with others, exchanging ideas and comparing our ideas with other people. Besides, PBL emphasizes the importance of students' active participation in authentic learning tasks. Yet, we learn best when working alongside someone who is already good at the tasks. This is the essence of apprentice-like learning. In fact, the design of PBL lessons must involve turning classrooms into communities of learning, where students work cooperatively toward common goals – the solution of a problem. The tasks involved in transforming a class of students into communities of learners, include – on the teacher's part – creating a positive atmosphere of learning where knowledge gaps and mistakes can be viewed in a positive way, such as another opportunity to learn; directing students in productive group work; monitoring those groups; and facilitating inquiry through continual questioning and reflecting activities.

In the process, the PBL students' active inquiry should be guided by some systemic efforts, with the instillation of purposeful actions. First, the learner should be involved in an authentic experience that genuinely interests him or her. Second, within this experience, the learner should encounter some genuine problem that stimulates thinking. Third, in solving the problem, the learner must acquire information and form possible, tentative solutions that may solve the problem. Fourth, the learner must test these solutions by applying them to the problem. Indeed, observation-interpretation-application itself helps the learner to better understand the process of problem solving and become a better self-directed learner.

One of the PBL learning experiences is to enable knowledge development and transfer among teachers and students in an interactive and collaborative atmosphere. Students actively participate in generating, accessing and organizing the required information for problem identification. They construct knowledge by formulating their ideas into words and then developing these ideas as they react to other students' or teachers' responses to their formulations. Knowledge construction can then be considered as the process of progressive problem solving, which encourages students to be innovative, create intellectual property, and develop and acquire expertise. To achieve these knowledge tasks, academic staffs need considerable skill and know-how to deal with the acquisition, creation, packaging and application of emergent knowledge. Often, we might need help from the wider community of professional expertise well beyond the domain of a local organization. The suitable design of essential IS support to help instructors with the PBL style of teaching thus represents a tremendous challenge in the Center for PBL Support.

FUTURE TRENDS OF ARCHITECTING PBL-BASED IS SUPPORT

To collaborate through the Center to provide online learning support is to work in a joint intellectual effort, to partition problem solving to produce a synergy such that the performance of the whole exceeds the performance of any individual contributor. The central issue is how learning is transferred from the individual to the group or community level. Here, we are 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 the basic learning processes can we manage the design of IS support consistent with the issues of the complex problem situations. Indeed, to manage is to try to cope with a flux of interacting events and ideas that unrolls through time. Our job is to try improving the situation, seen as problematical, or at least as less than perfect; and the job itself can be considered as never fully done, because as the situation evolves new aspects calling for attention emerge, and yesterday's solutions may then be seen as today's problems. In this regard, soft systems methodology (SSM), developed (Checkland & Scholes, 1999) expressly to cope with the situation in which the people involved in a problem situation perceive and interpret the world in their own ways and make judgments about it using standards and values that may not be shared by others, could well be considered an organized way to tackle the messy situations.

The Basic Shape of SSM

Consider that we are individuals conscious of the world outside our physical boundaries. One of the most obvious characteristics of human beings is our readiness to attribute meaning to what we observe and experience. Namely, we can think about the world in different ways, relate these concepts to our experience of the world and so form judgments that can affect our intentions and, ultimately, our actions. Put simply, we can take purposeful action in response to our experience of the world. By purposeful action, we mean deliberate, decided, willed action, whether by an individual or a group. In SSM, the focus is on an organized set of principles (methodology) that guide action in trying to manage the real-world problem situations (Bulow, 1989). The basic idea is to formulate some models of purposeful activities which, it is hoped, will be relevant to the real-world situation, and use them by setting them against perceptions of the real world in a process of comparison. That comparison could then initiate debate, leading to a decision to take meaningful action to improve the part of real life under scrutiny. In this regard, the use of SSM can be seen as a process that learns its way to the meanings that characterize an organizational context. This idea of learning the meanings by which people sharing a human situation seek to make sense of it, is a significant feature of SSM (Checkland & Scholes, 1999).

Thereby, a simple walkthrough of the SSM approach is this: Find out about a situation in the real world that has provoked concern; select some relevant concepts that may be integrated into different human activity systems (HAS) in SSM; create HAS models from the relevant accounts of purposeful activity; use the models to question the real-world situation in a comparison phase; use the debate initiated by the comparison to define meaningful action that would improve the original problem situation. It should be noted that taking the action would itself change the situation, so that the whole cycle could begin again, and is in principle never-ending. SSM does that in a coherent process that is itself an enquiring or learning system, and within the process of SSM we resort to models of purposeful human activity systems to provide help in articulating and operating the learning cycle from meanings to intentions to purposeful action.

The Use of SSM in the Creation of IS Support

To elaborate further on the discussion of SSM, it would be worthwhile to cover some ideas of organized purposeful action, because the use of SSM in IS work always involves the attribution of meaning (Checkland & Holwell, 1995), which is a uniquely human act

Let any purposeful activity be represented by an arrow *A*. This action, being purposeful, will be an expression of the intention of some person or persons *B*. Since *A* is a human action, there will be someone or several people, *C*, who would take the action. The action will have an impact on some person or group of persons, *D*, and it will be taking place in an environment that may place constraints, *E*, upon it. Besides, since human autonomy is rarely total, we can add some person or group, *F*, who could interfere with or stop the action from being taken. In practical scenarios, it is possible that the same person or persons could be one or more of the elements *B*, *C*, *D*, *F*, since they are roles, not necessarily individuals or groups. Overall, this simple model of a purposeful action may be expressed as $\boldsymbol{A = (B, C, D, F) + E}$, representing one way of thinking about the human activity system for purposeful action. Accordingly, it seems most appropriate to assume that the purpose of creating an organized IS is to serve real-world action; namely, organized provision of information is always linkable in principle to action (Checkland, 1981, 1983): to deciding to do things, doing them, observing and recording the results – and then, if necessary, modifying the deciding, doing and recording. Thus, designing an IS will require attention to the purposeful action the IS serves, and hence to the meanings that make those particular actions meaningful and relevant to particular groups of actors in a particular situation. This is applicable in the case of architecting IS support for collaborative learning, especially in the context of PBL.

In other words, if we wish to create an appropriate IS in the exact sense of the phrase, we must first understand how the people in the situation conceptualize their world. We must find out the meanings they attribute to their perceptions of the world and hence understand which action in the world they regard as sensible purposeful action, and why. Having obtained that understanding, we shall be in a position to build some of the purposeful models and use them to stimulate debate aimed at defining some human activity systems (HAS) widely regarded by people within the situation as truly relevant to what they see as the required real-world action. Once an agreed truly relevant system has emerged, SSM requires us to ask of each activity in the model: What information would have to be available to enable someone to do this activity? From what source would it be obtained? In what form? With what frequency? Besides, we need to ask what information would be generated by this activity. To whom should it go? In what form? With what frequency?

In this way, an activity model may be converted into an information-flow model. Given the information-flow model, which is agreed to be a necessary feature of the situation studied, we may further ask what data structures could embody the information categories, which characterize such information flows. It is only then that we could start the design of a suitable information system, which should yield the information categories and information flows required by the structured set of activities regarded as truly relevant to the real-world action that is itself relevant according to the meanings people in the situation attribute to their world as a result of their world views.

CONCLUSION

This article investigates the context of IS design, targeted for learners in an online support environment that aims to develop their abilities to learn, to engage in collaboration, to appreciate multiple perspectives, to evaluate and to actively use and construct knowledge. The discussion aims to underline the importance of SSM in the process of IS design and construction, which should meet several essential challenges: First, designing IS support is not usually concerned with well-defined problems, but with the ill-structured problem situations with which IS professionals have to cope. Namely, IS work needs to make sense both to those who work in IS and to those whose concern is organizational imperatives; namely, online learner support based on purposeful action (PBL) in our discussion. Second, it needs to encompass changes in practice, made possible by technical developments. Third, it must be robust enough to remain valid, as the technology itself and ways of using it continue to develop

Our research is driven by a belief that the design issues of IS support must be situated in the context of social processes in which, in a specific learning scenario, a particular group of people can conceptualize their world and hence the purposeful action they wish to undertake. This provides the basis for ascertaining through modeling of purposeful human activities what information support is needed by those who undertake that action. Only then does it become appropriate to ask how modern IT can help to provide that support. And we attribute this development philosophy to the essence of SSM in conceiving purposeful IS support. The chapter concludes by reiterating the main context for IS work is scenario-based meaning attribution, and meeting the challenge of designing suitable IS' starts from a re-thinking of what is entailed in providing informational support to purposeful action in the real world of learning. This is often facilitated by the provision of an important process constantly attended to, and integrated into the organizational and design activities by which IS professionals could use to get informed of the learners' continual adjustments to its external challenges.

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KEY TERMS

Constructivism: A theory of learning based on the idea that knowledge is constructed as learners attempt to make sense of their experiences. It is assumed that learners are not empty vessels waiting to be filled, but rather active organisms seeking meaning: Regardless of what is being learned, learners form, elaborate and test candidate mental structures until a satisfactory one emerges.

Information Systems (IS) Support: An IS function supporting people taking purposeful action. This is often done by indicating that the purposeful action can itself be expressed via activity models, a fundamental re-thinking of what is entailed in providing informational support to purposeful action. The idea is that in order to conceptualize, and so create an IS support that serves, it is first necessary to conceptualize that which is served, since the way the latter is thought of will dictate what would be necessary to serve or support it.

Meaning Attribution: An intellectual activity involving one's body of linked connotations of personal or collective interest, discrimination and valuation that we bring to the exercise of judgment, and which tacitly determines what we shall notice, how we shall discriminate situations of concern from the general confusion of ongoing event and how we shall regard them.

Online Learning Support: An electronic organizational system that helps transfer learning from individuals to a group (and vice versa), provide for organizational renewal, keep an open attitude to the outside world and support a commitment to knowledge.

Problem-Based Learning (PBL): A teaching strategy designed to help students learn problem-solving skills and content through using a problem (often, a genuine real-life one) as a focal point for student investigation and inquiry. PBL is often implemented through encouraging students to work cooperatively in teams to experience shared creation and collective problem solving. An important goal of PBL is the development of self-directed learning in students when they become aware of and take control of their learning progress. Self-directed learning is a form of meta-cognition, which involves knowing what we need to know, knowing what we know, knowing what we do not know and devising strategies to bridge these gaps.

Soft Systems Methodology (SSM): A methodology that aims to bring about improvement in areas of social concern by activating in the people involved in the situation a learning cycle that ideally is never-ending. The learning takes place through the iterative process of using systems concepts to reflect upon and debate perceptions of the real world, taking action in the real world and again reflecting on the happenings using systems concepts. The reflection and debate is structured by a number of systemic models of purposeful activities. These are conceived as holistic ideal types of certain aspects of the problem situation rather than as accounts of it. It is also taken as given that no objective and complete account of a problem situation can be provided.

Transmissive Pedagogy: Teaching based on an assumption that students receive information from the teacher and slot it straight into an empty ledge base or, at best, work on it later to make it their own.