KNOWLEDGE SHARING AND PROBLEM-BASED LEARNING

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ABSTRACT
Learning is the acquisition of knowledge. Sharing is a way of attaining new knowledge among learners. Exploring the behavior of knowledge sharing (KS) is essential to understanding synergy, refining a problem definition, assessing alternatives, deciding the best path forward, and implementing a practical solution. KS mechanisms are contributions to databases or websites to formal and to informal interactions, and to communities of practice. Problem-based learning is a guided process during which learners collectively and progressively understand an ill-structured, complex real-world situation, apply prior and new knowledge, and devise a jointly constructed resolution. The research opportunity acknowledges that certain projects have vaguely defined goals, hidden constraints, and multiple alternative paths, mixed or vague criteria for evaluating a scenario in order to decide on a best solution. The co-authors recently conducted a qualitative case study to enhance the capstone experience, comparing Computer Information Systems Program undergraduates with graduates for sharing ideas, revealing characteristics of explicit and tacit knowledge and presenting a solution. The research explored KS behaviors which generated trust, cultivated relationships, acknowledged motivation, and sustained a culture of collaboration. The objective accomplished was to focus on the capstone experience and to record narratives about how project teams are: (a) influenced by behaviors of collaboration, (b) sharing knowledge, (c) thinking critically, evaluating possible actions, and (d) applying the guidelines for deciding on a practical course of action.

INTRODUCTION

When students are working on a team project, they are engaged in an environment of knowledge sharing (KS). If the objective of the project is to provide solutions to a real-world problem, the process requires a great deal of collaborations among students and their sponsors. During these interactions, students are exposed to new information relevant to solving “real world” problems. In the studies of the problems, they are acquiring new knowledge. New problems—from the studies and from among team members—arise throughout a structured process resulting in new learning. Hence, students benefit by being engaged in a problem-based learning (PBL) environment.

The purpose of this paper is to share knowledge and ideas to inspire and set the stage for additional research into the dynamic influence of higher education programs. The authors have recently conducted a qualitative case study of comparing undergraduates with graduates students’ capstone project experiences of the Computer Information Systems program. The objective was to find out how KS relates to PBL, and how both blend in for student's capstone project. Practice and a better understanding of the KS and PBL environment will have the potential of preparing adult learners to be productive in the workforce for solving complex real-world problems.

DATA, INFORMATION, KNOWLEDGE, AND WISDOM

In preparation for a discussion of KS, it is essential to have a common understand of the concepts and definitions of data, information, knowledge, and wisdom. Davenport and Prusak (2000) defined data as "a set of discrete, objective facts about events" (p. 2), information as "a message, usually in the form of a document or an audible or visible communication" (p. 3), and knowledge as "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" (p. 5). They included wisdom into knowledge because these entities are difficult to distinguish. Likewise, the focus of KS of this paper will be on sharing experience, information, and expert insight.

The relationship of the elements of data, information, knowledge and wisdom is often illustrated as a typical pyramid structure ground in data being at foundation, building upward through layers culminating in the application of knowledge together with wisdom of interpretation at the peak. The DIKW hierarchy, Figure 1, reveals that data are representative of facts or activities representing the "real world", whatever may be the area of interest for decision making, research or scholarship.

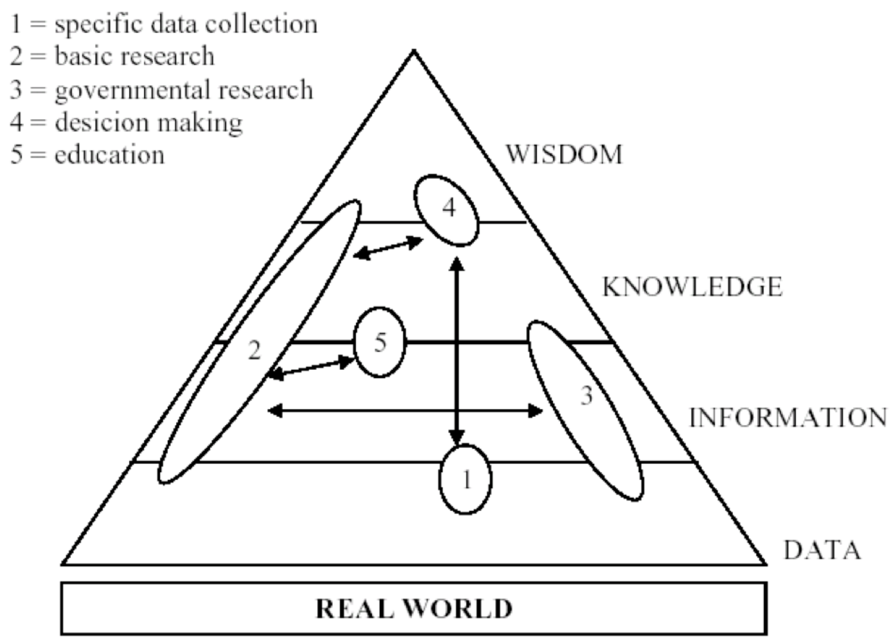

Figure 1. Biodiversity Information Hierarchy (Mortitz, 2011)

Mortitz's model also intersects the imaginary vertical boundaries between the domains which are crossed by five areas of interest, illustrated as ovals that cross over horizontal edge of the domains. Of interest to the authors of this paper is the area in which education can make a difference, namely to increase learners' capability to solve problems and to design solutions that reflect the real world in some manner and is dependent on a team sharing knowledge as it experiences an evolving awareness of problem definition and the most relevant factor to contribute to a meaning product from a joint effort during an academic learning event.

KNOWLEDGE CREATION: THE SECI MODEL

A widely accepted theory of Knowledge Management is often illustrated as four quadrants with a clockwise flow around the parameter labeled for the dimensions of tacit or explicit knowledge: S (**s**ocialization, tacit to tacit), E (externalization, tacit to explicit), C (combination, explicit to explicit), and I (internalization, explicit to tacit). The SECI framework supports the belief that individual learners acquire tacit knowledge through shared experiences, often informally, during a face-to-face social and school encounters. To rationalize and articulate a meaningful scenario, tacit knowledge is made more explicit in order to be shared and to be composed into a narrative or into concept models, images, or documents. The SECI model supports curriculum planners by offering a structure for lessons intended to transfer knowledge embedded within a program of curriculum to the instructors (who bring their own experience) then to learners. The intension is that the content of lesson "sticks" which means that learning is retained or applied to progressively complex or new situations. The clockwise pathway around the parameter of a graphical illustration of the SECI model indicates a flow of value creating knowledge between, among and across all learning situations. There are differing opinions about the ratio of knowledge which becomes explicit for a unit of study. The literature is split for scholar who examines KS within an organization or those who evaluated program offerings at an institution of higher learning. The studies which attempt to measure explicit knowledge often limit a context to a specific area of interest, such as a sequence of courses for a degree program, or a body of knowledge required for successful delivery of a product or service by supply chain. Lessons to prepare for certification exams exhibit knowledge that has already been made explicit. The metrics used for research are influenced by distinction named areas of interest, labeled as knowledge, which is retained by individuals.

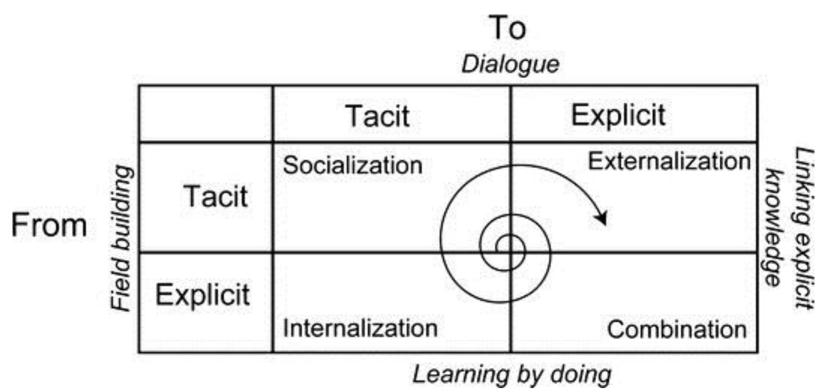

Figure 2. SECI model knowledge as a spiral (Travaille & Hendriks, 2010, p. 426)

The basic SECI model has often been adapted for meaningful research scenarios based on describing a gradual conversion from tacit to more explicit knowledge. Considering the dynamic of interactions such as those encountered in a research project are more like the SECI model shown in Figure 2 when the domain of attention is to start with dialog, progress to doing which results in a formalized protocols or procedures perceived to be progressive, somewhat sequential as shown in a loop traversing outward from the center. Role modeling is often perceived as occurring during socialization, whenever mentoring behavior by an experienced person shares what is known and what has worked well. The ongoing dialog sustains the experience with guided exercises and activities to encourage hands-on practice during which time the lesson is internalized, and later shared openly. Internalization refers to an embodiment or creation of new tacit knowledge evolved from the "access to codified knowledge through learning-by-doing, goal-based training or via interpretive knowledge presentations" (Travaille & Hendriks, 2010, p. 426).

Recent adaptations of the early SECI models have moved away from the implied sequential and expanding navigation of an expanding spiral. Replacing the cornucopia pathway is a model four quadrants and a pathway identified as learning loops, implying that dialog and actions flow between the evolving phases, responding to specific situations, acquiring new knowledge, becoming more explicitly articulated. The learning loops framework can be observed as clarifying a progressive maturity of thinking exhibited by people in the domain of knowledge. According to Yeo, a "juxtaposition of complexity and systematization is realized in the dynamics subsumed within each distinct phase of problem solving" (2008, p. 324, 2007, p. 48).

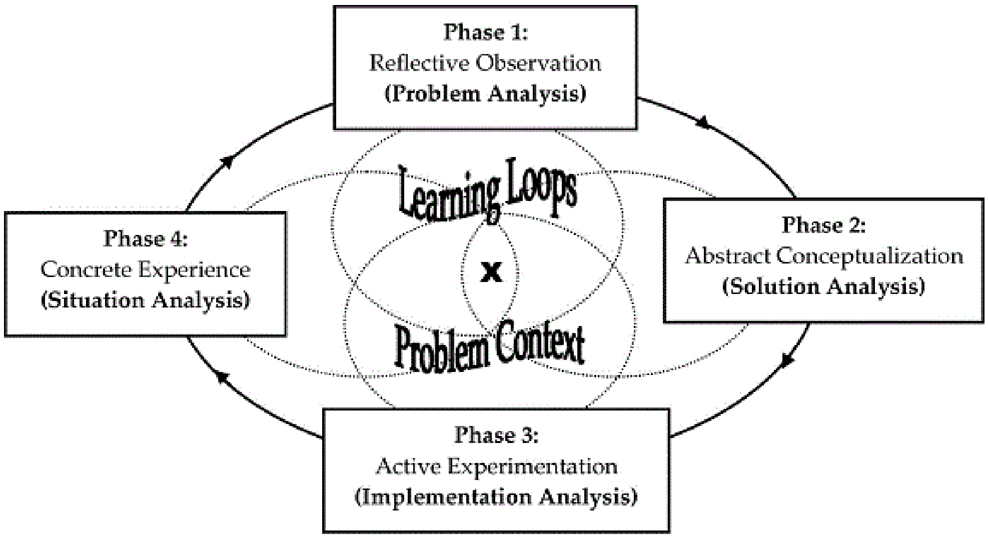

Figure 3. Model of PBL in workplace context
(Adapted by Yeo, 2008, p. 324, 2007, p. 48, from Kolb 1984, Cockerill et al. 1996)

As illustrated in Figure 3, Yoe's version of Kolb's original ideas is recognized as a flexible and dynamic environment for exchanges of new thinking and explicit ideas in business "real world" scenario. Yeo's composite framework marks with an X a hub of overlapping domains of knowledge, to defend the declaration that "strategy ultimately helps to create for the workplace an intrinsic source of competitive advantage" (Yeo, 2008, p. 322). Travaille and Hendriks considered the risk that the entire process may be perceived to be an individual responsibility. They suggested that groups and programs "may prove effective, via the development of networking competencies in researchers, recruitment policies and drafting mentoring programs (2010, p. 438).

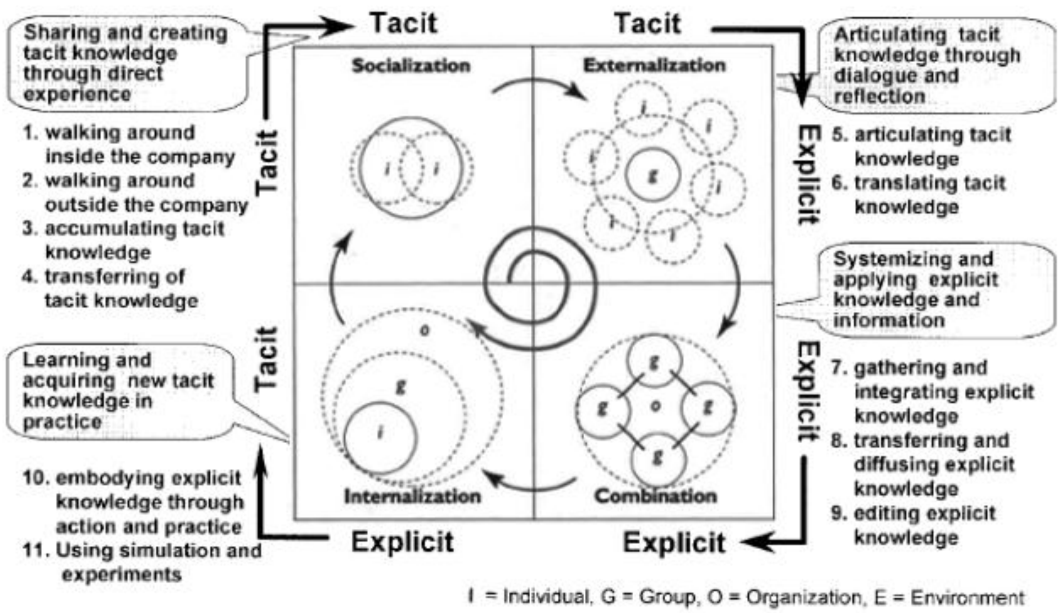

Figure 4. SECI model of knowledge creation (Nonaka & Toyama, 2003)

The basic simple SECI model serves to structure a sequence of steps starting with a theme, delivering lessons or tasks to begin a process of refining each lesson in a course set up to be a collection of learning opportunities. Illustrated an expanded version of the SECI model (Figure 4), Nonaka and Toyama (2003) retains a spiral radiating outward from the center. This comprehensive knowledge creation model does allow readers to infer a possibility that cycling around external and internal elements, makes multiple evolutions until explicit knowledge is embodied into evidence. This version of the SECI model gives credit to engagement of individuals, groups, an entire organization and the external environment. It is indeed a context for both KS and PBL to flourish.

FLOW OF KNOWLEDGE

Knowledge is generally classified as (a) explicit—knowledge that is codified, documented, captured, and (b) tacit—knowledge that is private and exist only within the individuals (Dalkir, 2005; Frappaolo, 2006; Khairah & Singh, 2008). A specific role that tacit knowledge plays in knowledge management is as factors that explain or predict the “stickiness” of a transfer (Mooradian, 2005). Knowledge transfer that entails more efforts is perceived as stickier. "Knowledge is sticky. Without a systematic process and enablers, it won't flow" (O’Dell, as cited in Woodill & Wright, 2011, p. 1). The slowdown of knowledge flow is often due to the stickiness of a transfer (Szulanski & Cappetta, 2003), however, the term stickiness can describe new information that is retained as knowledge.

In the literature, the concept of flow of knowledge is more than just metaphorical. The barriers to flow were examined by Szulanski in 1994, in which he identified barriers as ignorance, weak capability by the recipient, missing social relationship between sender and receiver, and duration of time for knowledge transfer to occur. The concept of barriers to flow has been listed with identity of casual factors by Lin, Tan and Chang (2008, as cited in Woodill & Wright, 2011, p. 13). Catching the flow at meaningful learning points is a context for PBL and KS to acknowledge a balance.

KNOWLEDGE SHARING

In a group learning environment such as a team project, sharing knowledge among team members is crucial and should be encouraged. KS usually involves the characteristic of consideration (von Krogh, 1998) and is distinct from knowledge creation because KS is about "the process intended at exploiting existing knowledge" (Christensen, 2007, p. 37). To capitalize on KS, organizations could (a) discourage knowledge hoarding and recognize knowledge givers, (b) reinforce KS as a cultural norm, (c) invest in codifying tacit knowledge, (d) match knowledge transfer mechanisms, (e) ensure knowledge retention by the receivers, and (f) lower the cost and increase the speed of the knowledge transmission channels (Gupta and Govindarajan, 2000). Bartol and Srivastava (2002) proposed that "rewards based on team performance are likely to enhance knowledge sharing within teams" (p. 69). Students working on a team project are often graded (rewarded) based on group efforts and contributions, therefore, genuine KS is likely to occur.

PROBLEM-BASED LEARNING

There are many definitions of PBL, each reflecting the context of an author or a team conducting research or implementing a change. For this paper, PBL is defined as a cyclical situation in which learners collectively solve an ill-structured, complex problem accessing prior knowledge, conducting research and devising a plan of action. According to Clark (2009), PBL is an instrumental environment in which participants tackle "carefully constructed, authentic job tasks or problems". The author also described PBL as scenario-based learning which activates prior knowledge as a framework for constructing new knowledge.

PBL IN THE CLASSROOM

To illustrate the modest beginning, an overview starts with a buy-in decision that the PBL protocol will increase the value-added learning and ends with a problem solved, gathering evidence of improvements gained in understanding the practice. The basic flow model (See Figure 5) introduces the concept and meaning of PBL, in a context of academic exercises for curriculum design. As courses progress in a program the problem become increasing more complex and realistic when compared to the elusive "real-world", whatever that term comes to mean in an academic situation.

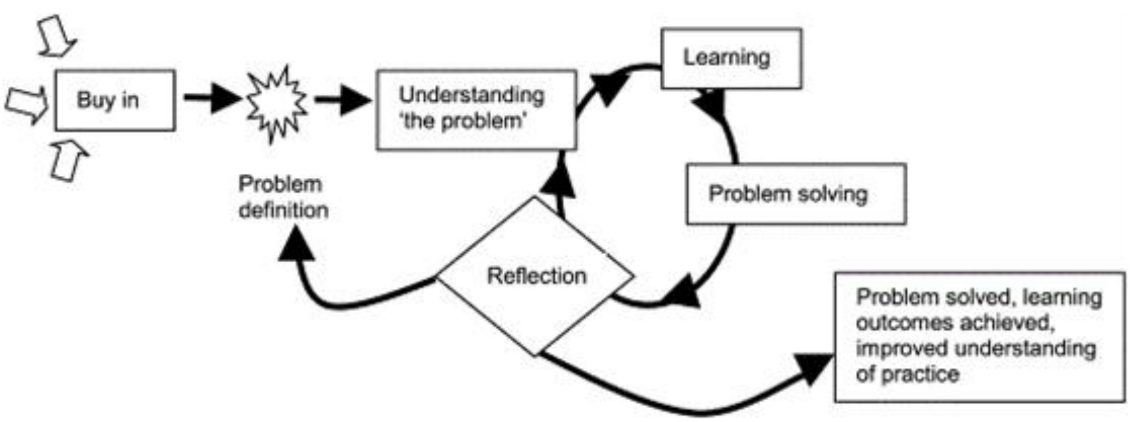

Figure 5. Basic Problem-Based Learning Overview (Stonyer & Marshall, 2002)

RELATIONSHIP BETWEEN KS AND PBL IN TEAM PROJECTS

In all learning settings, KS yields positive outcome to all learners—everyone gains. Contrary to sharing tangibles, KS is positive non-zero-sum (where one's gain does not equal to the other's loss). In most non-team learning situations, the common barrier to KS is due to the perceived belief that status and award go to knowledge owners (Davenport & Prusak, 2000). However, in the student's team project situation, where all members share a common goal and reward of seeking solutions to the problems, barriers to KS diminish. Through the synergy of KS among team members, a lot of learning is taking place. KS significantly enhances the quality of learning of student's team projects and PBL breeds new knowledge resulting in even more KS collaborative experiences for the team.

BEHAVIORAL ASPECTS OF KS AND PBL

As an ideal approach for handling complex situations, the action learning program developed for Pauleen's case study provides a simple framework for studying team leadership (See Figure 6). Many educators trust action learning which is best known for applying lessons, experiences or insights from one cycle of learning to a next cycle during which solving a problem or articulating new knowledge is expected and explicit. Action learning has "an iterative cyclical nature often involving a same learning group" (Pauleen, 2007, p. 231). Thus, action learning is a practitioner's way of supporting knowledge sharing when problems are the means by which explicit knowledge is generalized.

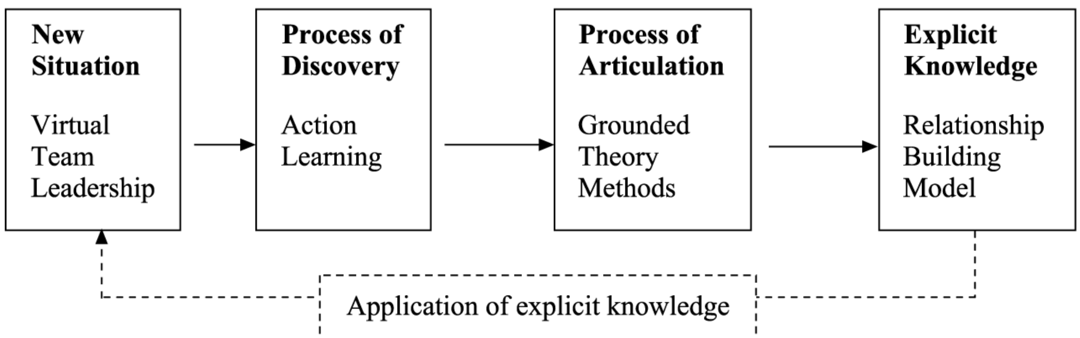

Figure 6. Making Shared Tacit Knowledge Explicit by Action Learning and Grounded Theory (Pauleen, Cirbitt, & Yoong, 2007)

ROLE OF LEARNER IN GAINING KNOWLEDGE

Bloom's taxonomy is familiar to both new and veteran scholars. The taxonomy has anchored pedagogy with frameworks of keywords and domains which suggest a steady progression of engagement by learners, from acquiring the basics, understanding concepts, applying new knowledge, analyzing complex situations and finally to realizing more sophisticated consciousness of knowledge. According to Anderson et al. (2004) novices try to understand a situation and remember the facts or concepts of formal instruction. Further, practitioners operate at the level of analyzing a situation and applying previous knowledge (both implicit and explicit) to solve an academic problems set up to represent the "real world" either as generalize or specific case studies. Salisbury perceived that motivated practitioners "already understand what to do and remember how to do it" (2008a, p. 221), by capturing, integrating and scaffolding previous solutions, applying their own knowledge to a new problem within the domain of procedural knowledge.

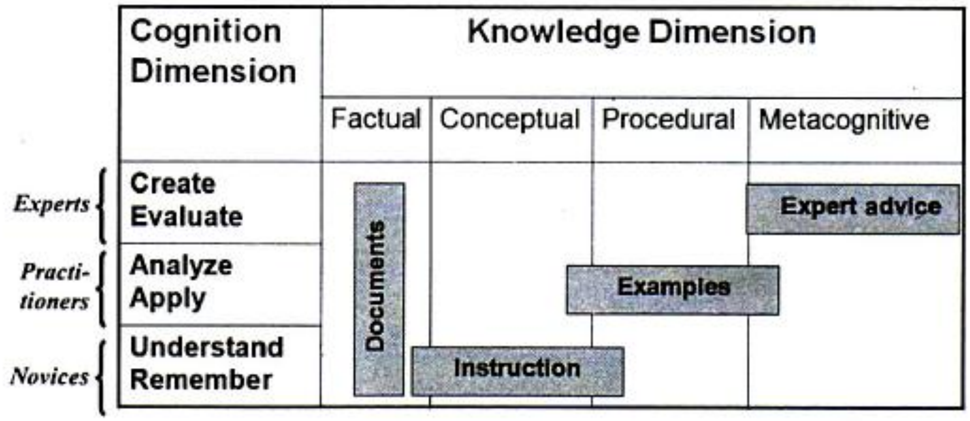

Figure 7. Differentiating learners seeking knowledge (Salisbury, 2008a, p. 139)

Salisbury's framework (Figure 7) shows knowledge as a dimension with four sub categories: factual, conceptual, procedural, and metacognitive and showing progress upward for cognitive dimension as novices expand their awareness of way to learn, think and perform as they take on the role of being practitioners. Salisbury's adaptation of Bloom's taxonomy framework illustrates the opportunities present when experts are engaged, evaluating the situation, sharing advice, offering unique solutions within the dimension of metacognitive knowledge. In the context of e-Learning, Salisbury (2008b) points out that documents have the purpose of capturing and disseminating factual knowledge such as terminology, specific details, and elements. Salisbury acknowledged a context scenario about quality assurance and activated which heavily uses documents and calls for "repurposing knowledge assets" (Salisbury, 2008b). Regarding knowledge shared during learning activities, another practitioner declared that "meta-abilities develop individual influencing skills and sharing attitudes" … two elements that enable individuals to externalize the own tacit knowledge, namely "creative idea, actions, reactions and reflection" (Selamat & Choudrie, 2007). As a familiar and flexible framework, the idea that learning is progressive compliments the strategies to provide new knowledge for solving complex problem.

ROLE OF KNOWLEDGE FACILITATOR

The role of trained knowledge facilitators is about having trained communicators specializing in relevant techniques in inductive analysis and guiding teams. Research on this theme suggests that organizations accept training from academics to pilot programs to model that explicit knowledge discovered during a process of refining the relevant knowledge (Pauleen, et al, 2007, p.237). Do these programs increase the practical knowledge of IT professions? What else can be done to elevate novice learners from the domain of understanding and remembering, to a level of practitioner for analyzing, applying and sharing knowledge? What proven procedures can add value to the challenges address by the field of Information Technology for preparing people to think critically? The authors decided to explore answers to these research questions.

PBL ACTION STEPS

Whereas some important lessons are the enriching experience of critical thinking, other lessons lead directly to a capstone project that translates the proposed solution into a design for an end product (Lauridsen, 2012).

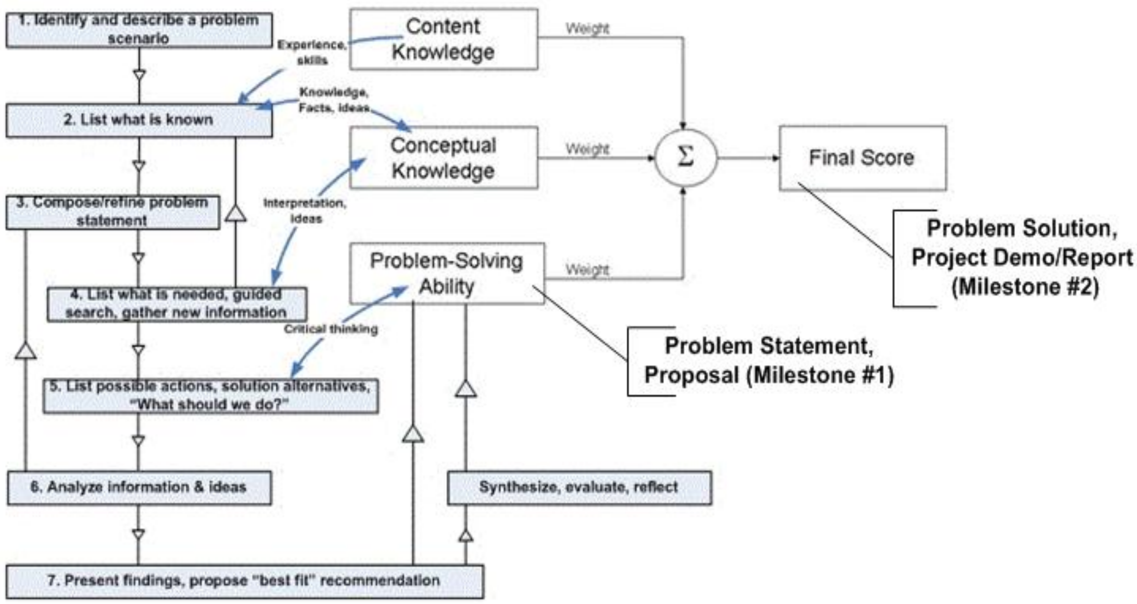

Figure 8. PBL Action Steps Integrated with Course Assessment (Lauridsen, 2012; Masse, et al. 2009)

An and Reigeluth practitioner's advice included for the environment, "provide both synchronous and asynchronous communication media" and for assessments, "assign a considerable portion of the grade to learning and the problem solving process" (2008, p. 13). How to do that? The answer can be inferred from the advice "help students divide tasks properly so that they can collaborate rather than cooperate" (An & Reigeluth, 2008, p. 13) that a course facilitator works closely with the PBL teams, observe the behaviors and outcome generated from the approach. The diagram in Figure 8 synthesizes several scholarly and practitioner sources describing the PBL process using seven steps integrated with four constructs useful for a formal study of assessments, conceptual knowledge, contents and problem solving ability (Masse et al., 2009, p. 3).

The PBL protocol is composed as actions steps that offer a context for tackling problem sequentially but not linearly since flowing back to previous steps to reinforce learning, not with repetitions but with expanded awareness: 1) Identify and describe a problem scenario; 2) List what is known; 3) compose and refine problem statement(s); 4) List what is needed, guided search, gather new information; 5) List possible actions, solution alternatives, ask and answer "What should we do?"; 6) Conduct analysis of information and ideas collected, iterating back to refine the understanding of the problem and forward to adjust what is needed; 7) Present findings, propose a "best fit" recommendation, followed by synthesizing, evaluating and reflecting on the process and on the results. The model aligns well with an academic setting in which content and concepts are offered by formal coursework. The path for acquiring the experience and skills of content (as facts and ideas) contributes to conceptual knowledge on the learning path toward interpreting and synthesizing the ideas and problem solving abilities that applies critical thinking. The call out labels on the model illustrate the two major milestones for capstone teams for the research conducted by the authors. The first milestone focused on demonstrating problem-solving ability by selecting and clearly defining a challenging problem and proposing a solution. The second milestone was for the team to develop and demonstrate its solution.

In exploring the value of the PBL protocol for IT Education programs, Lauridsen (2012) suggested that a benefit can be achieved by taking on a challenge, to explore the area of overlap between the practitioners' way of teaching problem solving with the potential that formal lessons on problem solving can become integrated with a formalized accredited curriculum for teaching with technology and business programs. An inference of the recent works published by scholars gives practitioners a chance to design and structure pragmatic lessons that can be applied to the "real-world" scenarios where solving problems takes critical thinking, namely, engineering, medical education and computer technology and software learning. During original research recently conducted by the authors, some useful lessons were applied.

RESEARCH FINDINGS

A qualitative research project was designed by the authors to compare perceptions of undergrads with graduates for introducing and using the PBL Protocol action steps integrated with capstone projects. A survey for pre/post was design, and a questionnaire set up on Survey Monkey to record participants' perceptions about the value received by the lessons. Findings were illustrated as the radar diagrams that captured awareness of the PBL protocol before and again after are shown for the seven factors that reflect the seven steps: (1) Issues, Challenges to be tackled; (2) Problem scenario clarified; (3) Objectives composed to refine understanding of the problem; (4) Solution awareness and information gathering; (5) alternatives assessment; (6) sharing knowledge, communicating ideas; (7) forward learning toward findings and a "best fit". The polygons are drawn for markers along the spines labeled with keywords on the parameter. The inner polygon drawn with diamond shaped metric points, indicates awareness before the lessons, captured from an intake survey of participants. The outer polygon, with square shaped metric points, indicates a change in the perceptions about the protocol captured from an exit survey after several in-class lessons and team break out practice exercises.

The insights gained from the research project about PBL blended with knowledge sharing add value to this area of interest. Modeled in the style of radar diagram, findings from intake compared to exit survey shows a gain in problem solving competencies in solving unstructured problems of capstone projects. The researchers will further analyze the variations observed between undergraduate student (Figure 9) and graduate student participants (Figure 10). For instance, one curiosity is to explore why the both undergraduates and graduates appear to have a modest measure of growth for all seven metrics but the graduate have an inverse for the second metric, the problem scenario. Perhaps understanding that will lead to improving the lessons offered by the capstone facilitator.

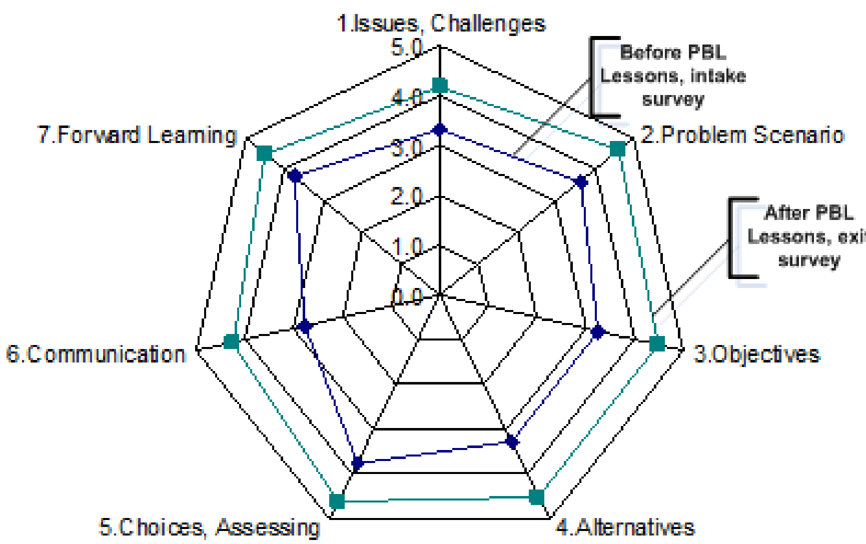

Figure 9. Undergraduate Student Participants N=7

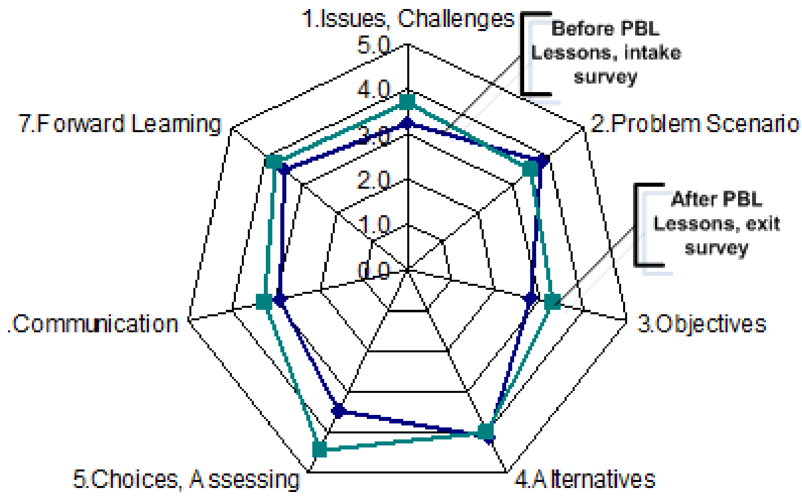

Figure 10. Graduate Student Participants N=10

FURTHER RESEARCH

The researchers are planning to extend the case study research to include distributed learners who are acquiring Computer Information Systems skills, to answer, "How does facilitated PBL benefit a team when collaborating on designing and producing a solution that aligns business with technology?" The inspiration is to prepare adult learners to become problem solvers and critical thinkers in the professional world of business and technology challenges.

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