Building A Reflective Collaborative Learning System Model for International Cooperative Problem-based Learning in Engineering Education

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Abstract *— This paper is intended to building a reflective collaborative learning system model for international cooperative problem-based learning in engineering education.*
Problem-based learning aims to engage students in their own learning and to develop the skills of problem finding, decision making, and problem solving. To accomplish these goals, students pursue solutions to authentic problems collaboratively by asking and refining questions, debating ideas, making predictions, collecting and analyzing information, drawing conclusions, and communicating with others. As the various communication tools, especially internet-related, support students' learning processes and practice, more active and interactive learning activities are encouraged.
To support problem-based learning efficiently and effectively, well-designed learning and instructional strategies such as explicit goal establishment, scaffolding of the problem, expert coaching, providing ample knowledge resources, active and various communication tools, and collaboratively embedded activities among students are strongly recommended.
The reflective collaborative learning system to support problem-based learning is composed of four supportive parts: PBL activities flow management, personal learning, collaborative learning, and collaborative reflection.

Index Terms *— Reflective Collaborative Learning System, Problem-Based Learning, Collaborative Reflection, Engineering Education*

INTRODUCTION

Problem-based learning provides intensive and meaningful experience that evoke students' interests and aloe for active involvement in both individual and team learning activities. Problem-based learning reflects on many educational ideas that focus on humans' interaction with their environment [1] [4] [12].
By using problem-based learning with technology, learners have many opportunities to discover their interest and talents, make connections among different subjects for solving real problems, improve their social skills and higher order thinking skills, and develop technology skills in their work in school and for their daily life [2] [3] [5].
The lesson is that since the very invention of network technologies, humans have converted, subverted and transformed network technologies into ways to support and extend human communication, collaboration and community. Educational adepts also have played an important role in this history in transforming cyberspace into social space: emphasizing communication, community and collaboration as the heart of educational networking and collaborative learning [6] [8].
Educators keep focusing on learning how to use technology in meaningful context combining educational technology with the need and ability of students with instructional topics. For successful technology integration into problem -based learning, it is necessary to prepare adequate professional development programs and cooperative learning environments that encourage the appreciate of technology skills to enable students.
With this subject in mind, in this paper I present a reflective collaborative learning system model in order to support the process for international cooperative problem-based learning in engineering education. The model can be easily adapted to authentic problems arising in the engineering education area.

PROBLEM-BASED LEARNING

Problem-based learning is a form of contextual instruction that places great emphasis on student problem-finding and framing, and which is often carried out over extended periods of time [9] [11]. Problem-based learning places demands on learners and instructors that challenge the traditional practices and support structures of schools. Leaning from doing complex, challenging, and authentic problems requires resourcefulness and planning by the student, new forms of knowledge representation in school, expanded mechanisms for collaboration and communication, and support for reflection and authentic assessment.
Instructors need help to be coaches and facilitators. Instructors have to act as role models, manage multiple problems, consult in areas of limited expertise, guide with feedback, promote teamwork, recognize and intervene when problems

arise [7] [10]. Learners need support for taking on the whole problem, not just carrying out tasks assigned by the instructor. They need to draw from their own personal experience and interests, yet fit a problem within curriculum objectives and organize the work of the problem; they need to collaborate with peers and find mentors, resources, and guidance in order to achieve quality outcomes. They also need to make sense of their results and transform problem efforts into valued products and results. The Problem-Based Learning Support System (PBLSS) was created to help meet the needs of instructors and learners engaged in problem-based learning.

REFLECTIVE COLLABORATIVE LEARNING SYSTEM

The reflective collaborative learning system is a software application that integrates a number of tools designed to assist learners involved in investigations that closely parallel the work of real researchers. Such investigations take extended periods of time and consist of multiple factors requiring diligent attention. They also place strong demands on the cognitive resources of the researcher, and require collaboration; success often depends on skill and experience.
The reflective collaborative work system includes support for two instructional processes and four learning process [9]. The instructional processes are scaffolding and coaching. The learning processes are planning and resourcefulness, knowledge representation, communication and collaboration, and reflection. These processes and the components of the reflective collaborative learning system is summarized in Table 1.

Processes	Definitions	Methods
Instructional Scaffolding	Structural supports to assist novice learners in the performance of tasks for which they would otherwise be unprepared	•Interface design broadly scaffolds the steps of a project, the language of real science, and concerns which must be addressed in order for a project to be successful
Coaching	Situated responses to learner task performances which are targeted at bringing learner performance closer to expert performance	•Advanced, interactive help system that is context/task sensitive •Context sensitive guidance system
Learning, Planning & Resourcefulness	Tools designed to assist learners with the complex demands involved in planning and being resourceful within authentic research projects	•Scheduling tools for establishing specific objectives and their start and stop dates •Resources tool for specifying material and information resources necessary for the project
Knowledge Representation	Tools designed to assist learners in the framing, representation, and representation of their ideas, knowledge, and their development, and in deriving cognitive benefits from the act of representation.	•Representation of a project abstract, project goals, objectives, resources, and applications of the work •Scaffolding, coaching, and guidance systems fully integrated to assist in the representation process
Communication & Collaboration	Tools designed to support the exchange and sharing of ideas and results, collaboration between widely distributed participants, feedback, discussion.	•Integrated email with address book and embeddable URL's •Integrated point-to-point and group real-time chat facilities
Reflections	Tools to support self and communal evaluation and reification of previously completed work, with subsequent cognitive and physical revision, re-framing, and restructuring of ideas, assumptions and representations	•Tracking and storage of all revisions to a team's work •Multiple-window views for comparison of old and new work •Scaffolding, coaching, and guidance systems fully integrated to assist in the reflection process

TABLE 1
COMPONENTS OF THE PROBLEM-BASED LEARNING SUPPORT SYSTEM

AN ARCHITECTURE OF THE REFLECTIVE COLLABORATIVE LEARNING SYSTEM FOR INTERNATIONAL COOPERATIVE PROBLEM-BASED LEARNING

The structure operation principle of reflective collaborative learning system is in this study as described in Figure1. RCLS is composed of three parts: data base storing quantitative dada extracted from Learning process, knowledge base collecting qualitative information in such cases, know-how on collaborative learning activities, and the reflective collaborative learning base offering communication and reflection tool.

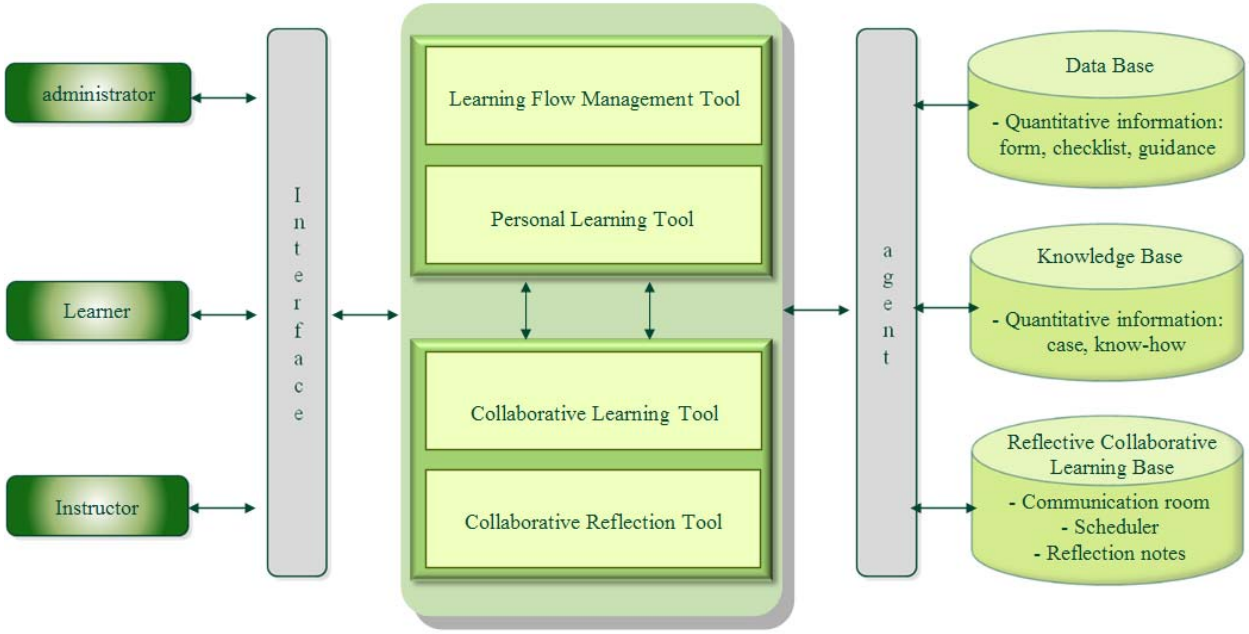

FIGURE 1
REFLECTIVE COLLABORATIVE LEARNING SYSTEM ARCHITECTURE

- Data Base – Resourcefulness

Data Base is a space to store information on current problem-based learning activities such as learners' interactions, their use of learning resources, and their production of results. The information is stored in a fixed form on work flow.

- Knowledge Base – Instructional Scaffolding

This tool provides implicit forms of scaffolding and coaching including modeling, giving feedback, structuring the way to do things, challenging the learner, providing hints, encouraging, and providing reminders. The interface provides designed implicit forms of scaffolding around a set of procedures that scaffold the process of doing authentic problems. These processes include setting goals, breaking complex goals down into achievable objectives, planning for these objectives by allocating time for periods of work, and anticipating and planning for the resources that must be available for an objective to be reached.

- Knowledge Base – Coaching

Coaching is also supported in Knowledge Base via communicating student work to the teacher in forms that support the instructional decision-making process. The approaches to communication and collaboration that PBLSS implements provide easy, consistent, and rapid access to student work by the teacher. Using an Internet browser the teacher can review the student's work, see previously made comments, and leave new comments. Thus, PBLSS helps represent student work and changes it in ways that are easy for the teacher to access and understand, and which facilitate the coaching process.

- Reflective Collaborative Learning Base - Planning

Planning Tools provides the complexities of real tasks by offering organizational and management tools for project planning. Since a problem is not a scripted task, planning tools need to be open ended and enable modification and redirection. Thus it provides tools for specifying broad goals as well as sets of objectives and associated time-lines that are steps to be accomplished in the meeting of those goals, and for specifying and for associating resources that must be available if the objectives are to be met.

- Reflective Collaborative Learning Base - Representation

A representation, once created, becomes a cognitive artifact and can function as a tool for thought. Transferrable from one learner to the next or from one context to the next, a representation can act as a lens to focus and guide inquiry. The

process of creating most artifacts, which we take to be synonymous with the act of representation, requires a number of cognitive processes to occur. Representation tools support knowledge representation by helping learners organize their thoughts into an analogue of a journal article that includes sections for an abstract, a statement of problem goals, a listing of specific objectives, project timelines, the resources needed to accomplish objectives, specification of the project team and responsibilities of the members, and an applications/extensions section in which they may draw conclusions from their work and make suggestions for further inquiry.

- Reflective Collaborative Learning Base - Communication

Communication tools include asynchronous communication tools and functions to check learners' states of the progress of tasks and the connection of team members. The task workplace includes functions for preparing tasks, individual learning, team learning, and task evaluation. The learning resources include lecture contents and reading materials. Learning tasks are designed to produce research reports and team outcomes while each team executes inquiry-based learning and problem based learning by theme.

- Reflective Collaborative Learning Base - Reflection

Reflection tools supports reflection by requiring learners to articulate their work, by facilitating comments and critiques from others, and by making it easy to review and compare previous work. By having several discourse and collaboration channels, it increases the likelihood that the learner's articulation will be reviewed and critiqued, thus encouraging further reflection. It provides for reificative reflection by tracking and storing every part of the project team's documents from the beginning of a project to its end. This kind of "reification" enables a learner to reflect in a systematic way on the problem-solving process, and to reach new conclusions or make elaborations they might otherwise not have. Reificative reflection brings powerful cognitive forces into play. Learners examining their own work and comparing it to that of others, to their own later work, or to a cognitive model, must organize information, elaborate upon concepts, and integrate ideas from potentially many sources.

CONCLUSION

The reflective collaborative learning system as PBLSS is an attempt, through a collaborative design process with instructors and students, to develop tools and structures carrying out projects that increase likelihood of students successful outcomes more likely. Through continuously cyclic design and revision, the reflective collaborative work system is becoming a valuable support tool in engineering education.

To support reflective collaborative learning for cooperative problem-based learning in engineering education efficiently and effectively, well-designed learning instructional strategies such as explicit goal establishment, scaffolding of the contents of the project, expert coaching, providing ample knowledge, group communication tools, and collaboratively embedded activities among learner are strongly recommended. The reflective collaborative learning system model will provide an environment for studying authentic learning, the processes of carrying out projects, and the structures needed for their support.

REFERENCES

[1] Bareell. J. (2007). Problem Based Learning: An Inquiry Approach (2nd Eds.), Cowin Press.

[2] Chung. J. C. C. & Chow, S.M.K. (2004). Promoting Student Learning Through a Student-Centered Problem-based Learning Subject *Curriculum. Innovations in Education and Teaching International*, 41(2) , 157-168.

[3] Fleming, D. S., A Teachers Guide to Project-Based Learning, AEL, Inc., Chaleston, WV, 2000.

[4] Gadner, H., Frames of Mind: The Theory of Multiple intelligence, 1993, New York: Basic Books.

[5] Güres, A., Aćikyildiz, M., Doğar. C., & Sözbilir, M. (2007). An Investigation into the Effectiveness of Problem-based Learning in a Physical Chemistry Laboratory Course. *Research in Science & Technological Education*, 25(1) ,99-113.

[6] Harasim, L., The Case for Collaborative Learning Online, *Preceedings of International Conference on KSET*, Seoul, Korea, , June 2003, pp.215-233.

[7] Hawkins, J., Supporting teachers in changing roles, A group paper from the NSF Educational Technology Workshop, *Setting an agenda for computer science in educational technology*, Washington, D.C.: Computing Research Association, 1995, pp.23-31.

[8] Kim, I., Cho, E., Development of a Reflective Collaborative Work System for e-Learning Contents Development, *Journal of the Korea Contents Association*, Vol.6, No.3, 2006, pp.108-115.

[9] Laffey, J., A Computer-Mediated Support System for Project-Based Learning, *Educational Technology Research and Development*, Vol. 46, No. 1, 1998, 73~86, 215-233.

[10] Suh, H., Moon, K., Agent Design for Online Collaborative Learning, *Preceedings of 20th Anniversary International Conference on KSET*, Seoul, Korea, September 2005, pp.241-249.

[11] Sungur, S., & Tekkaya, C. (2006). Effects of Problem-based Learning and Traditional Instruction on Self-regulated Learning. *The Journal of Educational Research*, 99(5), 307-320.

[12] Tan, .O. S., Chye, S., & Teo, C. T. (2009). Problem-based Learning and Creativity: A Review of the Literature. In O. S. Tan. (Eds.), Problem-based Learning and Creativity. Cengage Learning Asia Pte Ltd.