

A framework of PBL strategy integrated in LMS and a ubiquitous learning environment

D. T. Ku

Associate professor
Department of Educational Technology
Tamkang University

C-S. Chang

Associate professor
Department of Educational Technology
Tamkang University

Abstract- This study describes the design of problem-based learning strategy (PBL) integrated into LMS with mobile tools in a ubiquitous learning environment, which is called uPBL system. This paper discusses the analysis and design of PBL instructional steps for building a LMS system to create a new learning environment. A trial case was designed and implemented with elementary school teachers to obtain feedback and suggestions on the design of uPBL system structure. In the trail PBL outdoor activities coped with PDA devices, students were interested in mobile learning devices and the developed system. Also, students felt comfortable to solve the real live problems and communicate with team members without the obstacles of time and space. It is expected that students will be enhanced their learning performance with a well-designed learning environment via held technology devices. Experimental studies of students learning performance are ongoing in the next research step.

I. INTRODUCTION

With the advancement of network technology, e-learning has become the most popular method to deliver corporation training and instruction for all academic levels worldwide. In order to create a virtual and mutual platform to connect students and teachers, since early 2000s, Learning Management System (LMS) has been designed and developed to fulfill this very need [1]. According to the ASTD report [2], 91% of corporation and higher education are using at least one LMS and within only five year, from 2006-2009, its market value has grow from 583 million to 817 million us dollars. In higher education of the world, about 75 percent of the institutes have adopted at least one model or brand of LMS [3]. From the perspective of education, LMS is so popular because of its convenience and ability of engagement. It seems to provide a bundle of web based pedagogical and administrative tools for teaching and learning which has been waited for long time by educators [4].

However, LMS is not as promising as people expected. Even though LMS[s] "have become a standard 'one size fits all' technology 'solution' for online learning and teaching at most universities" [5], different from school administrators, instructors are not too crazy about those so called e-learning

solution technologies because the frontline users have difficulty to truly integrate instructional design via LMS. The current form of LMS is described as simply a better looking "FTP" (File Transfer Protocol)[6], LMS is also called a "page turning tool" which indicated that the existing LMS could not real connect learners in higher level think, or support active learning attitude [7]. The e-learning has been defined that the "e" is the technology and "how" to deliver in electronic form, and the "Learning" is the "what" and "why". It is about content and instruction [8]. If these two events could not happen simultaneously, there is no such thing called e-learning. If LMS is referred to the "e", how and where the "learning" should be?

Some studies pointed out that other than files exchange and announcement functions, LMS does not exact design for learning activities and interaction of learners [9], [10], [11]. The most of time LMS provides testing tools and access to students records, but lack of meaningful and rich interactive learning experience [12]. For that reason, some researchers have tried to put together some instructional modules and activities by using existing LMS for online learning and teaching [13], [14], [15]. Although some of them did report positive results and claim that LMS is possible to provide a learning environment for different teaching approaches, they also agree that for new technology-using instructors and novel instruction designers, to really integrate the useful teaching strategies with the fixed and unchangeable interface and tools of LMS together is a major challenge.

Therefore, this study attempted to construct a design framework for a unique online learning environment which works as a LMS but design for particular pedagogical strategy, problem-based learning (PBL) exactly. Integrating learning process of the PBL, this so called uPBL provides instructional design model and matched learning activity tools for instructors, and ubiquitous collaborative learning environment for students. The concept is to assure the meaningful teaching and learning at least in the PBL environment without the "one size fits all" ambition.

II. PROBLEM-BASED LEARNING AND RELATED LEARNING ACTIVITIES

Even though the concept of problem-based learning (PBL) can be tracing back to Kilpatrick and Dewey [16], Most current studies consent that McMaster University was the first to introduce the practical idea of the PBL into its medical schools in the 1960's. Since that, the PBL has been used in over 80% of medical schools of US [17] and also adopted in various content fields for all academic levels of classroom instructions [13], [18], [19].

The PBL method is a learner-centered and constructivist approach of instruction [19], [20], [21], [22]. Using the real-life situation and ill-structured problems, the PBL emphasizes the critical thinking and analysis ability, the interpersonal skill for collaborative learning, and of course, the problem solving ability [13], [21], [23], [24].

Some research argued that problem-solving is a kind of ability to utilize certain rules or principles to solve certain problems [25]. In order to solve problem efficient and effective, studying and inducing the process of problem-solving has been critical issue across various disciplines [26]. Although, those studies presented not quite the same, they included very similar problem solving process. Basically, the process of Hayes [27], Identify problem, form problem solving plan, search related information, implantation and evaluation may cover and represent all the arguments. Utilized the process, some studies developed problem solving activities to integrate the strategy of problem-based learning, see Table I.

TABLE I
COMPARING THE PROBLEM SOLVING ACTIVITIES FOR STUDIES

| Researchers | Problem Solving Activities |
|------------------------------------|---|
| Delisle (1997)[23] | Connecting with problem>setting up the structure>visiting the problem>revisiting the problem>producing a performance>evaluating performance and the problem |
| Stepien (2002)[28] | Join the project>question and investigation>develop problem solving plan>report the project |
| Chang, Lai, Wang, & Gan (2002)[29] | Connecting with problem>analyzing problem>developing plan>searching and collecting information>applying and experiencing> synthesizing and analyzing >reflecting and evaluation |

III. PROBLEM-BASED LEARNING STRATEGY MODEL INTEGRATED IN LMS DESIGN

Conceptual Design Framework of U-pbl

With the PBL approaches, planning activities along with the PBL process and matching the appropriate learning tools, u-PBL is a LMS that designed only for PBL learning project. The system framework included teacher interface (authoring interface), student interface (project working environment), database and handheld interface (wireless environment). Fig 1 shows the system structure of u-PBL.

Teacher interface: Based on the PBL process mentioned previously, teacher interface provides a PBL process sequence guideline for instructors. Instructors are able to create activities in each stage of the process and the object-oriented design allows instructors to select matched activities by

dragging tools into the project. Using “Developing plan” as an example, according to the initial conclusion of “analyzing problem”, students work on the project schedule arrangement and tasks assignment. Via various tools such as discussion board and chat room, team members are able to discuss such issue and instructor can also provide guidance. Gantt chart and calendar can be very useful tool for them to keep tracking the progress. The concept framework of “developing plan” shows in Fig 2.

Student interface: Once instructor has setup PBL project, students will receive the project (problem) and guidance in student mode from both computer and PDA. From student mode, students are able to have a clear overview about the entire project and process of problem solving. As a team work based project, each member is able to use available tools to communicate with other teammates and keep tracking the progress of the project. Also using “developing plan” as the example, students have moved to the second stage of the project. After they identified the problem, they use “discussion board” and “chat room” as the communication tools to reach the agreement and create “gantt chart” and working “calendar”. Every single step, discussion, working materials and personnel will be record by the system. Instructor is also able to monitor the progress of students from teacher mode and provide the timely support. Fig 2 shows the example project overview of the student mode.

Handheld interface: Creating a ubiquitous learning environment is one of the critical aspects of this study. During the problem solving process, students may need to go to the remote site for field study or collect evidences, and keep in touch with teammates and receive guidance from instructor are very important. Mobile handheld device provides a real experience opportunity to students to enjoy “learning by doing” in remote location and also keep connecting with each other. Figure 3 shows that instructor can provide timely assistant to students via the PDA and students also search build-in database for related issues and topics.



FIG 3. AN EXAMPLE OF INSTRUCTION GUIDANCE VIA THE PDA.

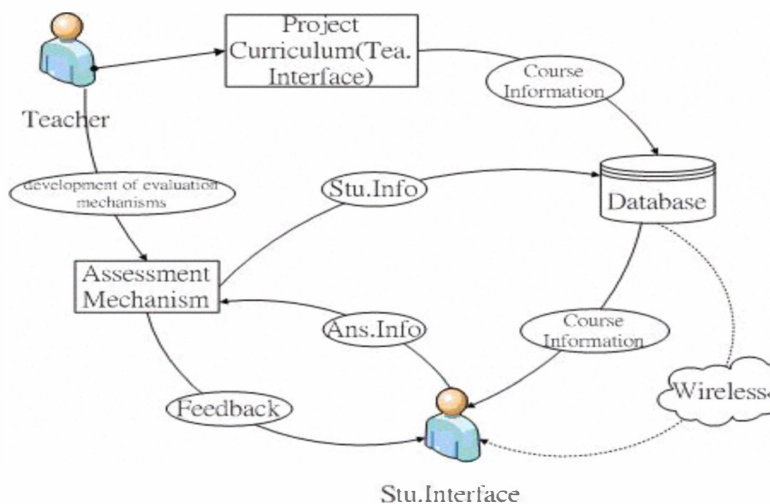


Fig 1. The system structure of u-PBL.

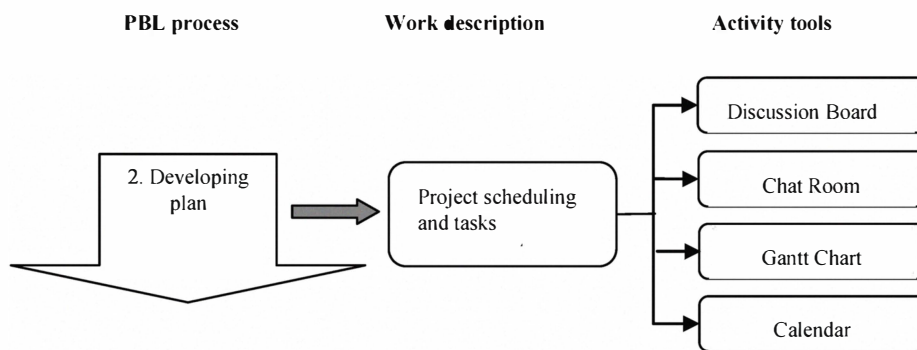


Fig 2. The concept framework of "developing plan"

In order to better explain how the u-PBL integrates a real PBL project, the following case study will present an example to describe how the u-PBL supports the "Mudslides" case.

IV. CASE STUDY

Recently, environment issues are critical and popular subjects to be discussed. Especially, Taiwan just faced the most severe "Mudslides" in two decades. Therefore, this study used "Mudslides" as the main content to design a PBL learning activities for one class of elementary school fifth grade students and also had a pilot testing regarding the functions and effect of the u-PBL. According to the approach of Chang et al. [34], the process of activities should include:

1. Starting from the real situation: Why do the "mudslides" happen?
2. Sharing different concepts
3. Comparing the knowledge "known" and "unknown" to generate more related questions
4. Using information technology to collect new information and learning
5. Inducing the new knowledge
6. Sharing the new knowledge

7. Recording the process of learning

Based on the process of activities, the lesson plan integrating with u-PBL presents on the Table II.

V. CONCLUSION AND FUTURE WORK

Reflecting upon the case study, interviews of learners and instructors showed very positive feedback to the PBL project online in the formative evaluation stage. Learners felt comfortable to solve the real live problems and communicate with team members without the obstacles of time and space. Teachers appreciate the system which is tailored specific for PBL and for both novel technology and new PBL instructors to design an effective lesson plan in a ubiquitous learning environment. Rather than traditional PBL project, u-PBL provides a brand new learning and teaching experience to students and teachers. Additionally, it is expected that students will be enhanced their learning performance with a well-designed learning environment via advanced technology devices. Experimental studies of students learning performance are ongoing in the next research step. In fact, several critical effects are worth to be discussed:

TABLE II. UPBL TOOLS IMPLEMENTED WITH THE PBL PROCESS AND ACTIVITIES IN “MUDSLIDES” ISSUE.

| Analysis | Design and Development | | Implementation | Evaluation |
|--|---|---|--|--|
| PBL process | PBL activities | Main purpose | uPBL tools | Indicator of Multi-Intelligences (MI) Performance competency |
| 1. Connecting with problem and analyzing problem | <ul style="list-style-type: none"> • Concept map • Listen and evaluation | Focusing on the problem and trying to use concept map and discussion to clarify the problem | <ul style="list-style-type: none"> ✓ Concept map ✓ Discussion board ✓ Note pad | Literature Logic Reflection Interpersonal skill |
| 2. Developing plan | <ul style="list-style-type: none"> • Known vs. Unknown(1) • tasks assign | To find out the unknown problems and create a project to solve the unknown. | <ul style="list-style-type: none"> ✓ Discussion board ✓ Gantt Chart ✓ Calendar | Logic Interpersonal skill |
| 3. Searching and collecting information | <ul style="list-style-type: none"> • Treasure hunting | Based on the project plan, learners use various technologies to search related and problem solving information. | <ul style="list-style-type: none"> ✓ Chat room ✓ Discussion board ✓ Wiki ✓ Search engine | Literature Logic Inquiry |
| 4. Applying and experiencing | <ul style="list-style-type: none"> • Known vs. Unknown(2) | Reviewing the new information and unknown, see if the problem has been solved or any problems still exist. | <ul style="list-style-type: none"> ✓ Blog ✓ Discussion board | Literature Logic Inquiry |
| 5. Synthesizing and analyzing | <ul style="list-style-type: none"> • Fishbone diagram* | Based on the correct information, using the right tool to find out the key point step by step. | <ul style="list-style-type: none"> ✓ Fishbone diagram ✓ Discussion board ✓ Wiki | Literature Logic |
| 6. Reflecting and evaluation | <ul style="list-style-type: none"> • Within group evaluation • Speak out loud | Learners have to appreciate others efforts and reflect upon their own works. | <ul style="list-style-type: none"> ✓ Blog ✓ Discussion board ✓ Peer review | Reflection Interpersonal skill |

1. Traditional PBL has been designed a face-to-face classroom environment. Both students and teachers have to spend tremendous time and effort, but u-PBL provides a unlimited working and learning environment to students and instructors. For students, team projects can be worked without time and space barriers, and manage schedule and work load effectively
2. PBL is a learner-centered instructional strategy. Therefore, the instructional process is different from the traditional one direction “teaching” approach. The Instructor works as a couch who provides guide and support to students. u-PBL emphasized the “couch” approach and the ubiquitous environment provides more and timeless communication channels between team members and instructor.
3. u-PBL also emphasized the “process of learning” rather than the “standard final answer”. Using multi-dimensional assessment, u-PBL collects system data, peer review and student reflection to evaluate the problem

4. solving process.
4. For the learning and life style of the digital native, u-PBL integrated the PBL instructional strategy and ubiquitous technology which is enhancing the motivation to influence the positive way of learning because of their personal interest in the approach of instruction and interaction.

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REFERENCES

[1] J. Mallon, C. Bersin, D. Howard, and K. O’leonard, “Learning management systems 2009,” *Bersin & Associates Research Report*, April 2009.

[2] R.K. Ellis, (2009)(eds.). *A field guide to learning management systems*. The American Society for Training & Development (ASDT), available at http://www.astd.org/NR/rdonlyres/12ECDB99-3B91-403E-9B15-7E597444645D/23395/LMS_fieldguide_20091.pdf, 2009.

- [3] H. Coates, "Leveraging LMSs to enhance campus-based student engagement," *EDUCAUSE Quarterly*, vol. 28, no. 1, pp 66-68, 2005.
- [4] H. Coates, R. James, and G. Boldwin, "A critical examination of the effects of learning management systems on university teaching and learning," *Tertiary Education and Management*, vol. 11, pp 19-36, 2005.
- [5] C. Steel, "Reconciling university teacher beliefs to create learning designs for LMS environments," *Australasian Journal of Educational Technology*, vol. 25, no. 3, pp 399-420, 2009.
- [6] D.T. Ku, "Cognitive domain and instructional tools integrate in design and development of LMS," *Journal of Educational Research*, vol. 137, pp 121-133, 2005.
- [7] S. Naidu, *E-Learning: A guidebook of principles, procedures and practices (2nd ed.)*. New Delhi: Commonwealth Educational Media Center for Asia, 2006.
- [8] R.C. Clark, and R.E. Mayer, *E-learning and the science of instruction*. San Francisco, CA: Pfeiffer, 2003.
- [9] X. Apedoe, "The interplay of teaching conceptions and course management system design: Research implications and creative innovations for future designs," *Course management system for learning: Beyond accidental pedagogy*, A. Jafari & P. McGee, eds., Hershey PA: Information Science, pp. 57-68, 2005.
- [10] J.G. Hedberg, "E-learning futures? Speculations for a time yet to come," *Studies in Continuing Education*, vol. 28, no. 2, pp 171-183, 2006.
- [11] M. Papstergiou, M. (2006). "Course management systems as tools for the creation of online learning environments: Evaluation from a social constructivist perspective and implications for their design," *International Journal on E-learning*, vol. 5, no. 4, pp 593-622, 2006.
- [12] C.J. Bonk, "The perfect e-storm: Emerging technologies, enhanced pedagogy, enormous learner demand, and erased budgets," *Proc. The Observatory on Borderless Higher Education*, London, UK, 2004.
- [13] L. Brodie, "Problem based learning for distance education students of engineering and surveying," *Proc. of the Connected-International Conference on Design Education*, Sydney, Australia, 2007.
- [14] T. Aravithan, and J. Worden, "Effective use of webct in a problem-based learning course for a dual mode delivery". *Proc. International Conference on Innovation, Good Practice and Research in Engineering Education (EE 2006)*, Liverpool, England, 2006.
- [15] T. Petrovic, and G. Kennedy, "How often do students use a learning management system in an on-campus, problem-based learning curriculum?" *Proc. ascilite 2005*, pp. 535-538, 2005.
- [16] G. Secundo, G. Elia, and C. Taurino, "Problem-based learning in web environments: how do students learn? Evidences from the 'virtual eBMS' system," *Int. J. Cont. Engineering Education and Lifelong Learning*, vol. 18, no. 1, pp 6-25, 2008.
- [17] D.T. Vernon, and R.L. Blake, "Does problem-based learning work? A meta-analysis of evaluative research," *Academic Medicine*, vol. 68, no. 7, pp 550-563, 1993.
- [18] D. Boud, and G.I. Feletti, *The challenge of problem-based learning (2nd eds.)*. London: Kogan Page, 1997.
- [19] T.M. Stewart, W.R. MacIntyre, V.J Galea, and C.H. Steel, "Enhancing problem-based learning designs with a single e-learning scaffolding tool: Two case studies using challenge FRAP," *Interactive Learning Environment*, vol. 15, no. 1, pp 77-91, 2007.
- [20] P. Wannapiroon, "Development of problem-based blended learning model in developing undergraduate students' critical thinking," *Thaicyper University Ejournal*, vol. 1, no. 2, available at <http://ejournals.thaicyperu.go.tr/index.php/ictl/article/view/39/39>, 2008.
- [21] H-H. Chen, W-J. Chang, and K-J. Chen, "Development of an e-learning platform based on the problem-based learning," *Computer Supported Cooperative Work in Design IV: 11th International Conference (CSCWD 2007)*, Melbourne, Australia., 2008.
- [22] I. McAlpin, and B. Allen, "Designing for active learning online with learning design templates," *Proc. ascilite Singapore 2007*, pp. 639-651, 2007.
- [23] R. Delisle, *How to use problem-based learning in the classroom*. Alexandria, VA: ASCD, 1997.
- [24] J.R. Savery, and T.M. Duffy, "Problem based learning: An instructional model and its constructivist framework," *CRLT Technical Report*, vol. 16, no. 1, pp 1-17. Indiana University, 2001.
- [25] P.L. Smith, and T.J. Ragan, *Instructional Design (3rd ed.)*. NJ: John Wiley & Sons, Inc, 2005.
- [26] D.H. Johnsson, *Learning to Solve Problem*. San Francisco, CA: Pfeiffer, 2003.
- [27] J.R. Hayes, *The complete problem solver*. Philadelphia: Franklin Institute, 1981.
- [28] W.J. Stepien, *Problem-Based Learning With the Internet Grades 3-6*. Tucson, AZ: Zephyr press, 2002.
- [29] C-S. Chang, Y-S. Lai, Y-L. Wang, and P-Y. Gan, "Development of an e-learning platform based on the problem-based learning," *Journal of Educational Media and Library Science*, vol. 40, no. 2, pp. 198-209, 2002.