

Facilitating Teaching CPS and Technology-based Content with Learning Management Systems

Chi-Un Lei, Kaiyu Wan and Ka Lok Man

Abstract—Teaching with learning management systems (LMSs) is shown to facilitate the teaching-learning process through asynchronously sharing of materials and ideas. In this paper, we explore the possibility of using LMS to support teaching in technological courses. In our study, we used LMS as i) a platform to share course materials and make bi-directional feedback/assessment in a common core (general education) course, and ii) a platform to manage laboratory activities in a general engineering course. After our one-semester (three-month) study, we found that LMS creates an efficient learning environment for sharing of ideas and materials as well as managing learning activities.

Index Terms—e-learning, general education, learning management system, technological education, higher education

I. INTRODUCTION

With recent advances in information technologies, learning management systems (LMSs) have been popularly used in universities. In brief, LMS is a software platform to record, track and deliver learning materials. In other words, LMSs can help instructors to manage resources for teaching (e.g. course materials, facilities, equipment), as well as assign learning paths to guide students. Meanwhile, students can manage their own learning progress (e.g., registration, tracking and notification of learning events), build learning communities, and conduct on-line self-learning and assessment activities. LMSs are also often used for collaborative learning, such as sharing of ideas and contents via forum and wiki. The development of LMS is shown to facilitate teaching and learning, encourage student's participation, and change the paradigm of higher education [1]–[3]. Among different LMSs, a free e-learning service platform Moodle (Modular Object-Oriented Dynamic Learning Environment) is often used by schools.

Meanwhile, in our tertiary institution (The University of Hong Kong), we have also designed new curriculum [4]–[6] and have adopted information technologies [7]–[12] to facilitate the process of teaching and learning. In particular, in the Department of Electrical and Electronic Engineering, we have adopted various information technologies, for knowledge advancement and dissemination.

Manuscript received January 11, 2013.

C.-U. Lei is with the Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong. Email: culei@eee.hku.hk

K. Wan is with the Department of Computer Science and Software Engineering, Xi'an Jiaotong-Liverpool University, China. Email: {nan.zhang,kaiyu.wan}@xjtlu.edu.cn

K.L. Man is with the Department of Computer Science and Software Engineering, Xi'an Jiaotong-Liverpool University, China, Myongji University, South Korea and Baltic Institute of Advanced Technology, Lithuania. Email: ka.man@xjtlu.edu.cn

The research work presented in this paper is partially sponsored by SOLARI (HK) CO (www.solari-hk.com), KATRI (www.katri.co.jp and www.katri.com.hk) and Research Grants from National Natural Science Foundation of China (Project Number 61103029).

In this paper, we give an evidence-supported discussion about the effectiveness of using LMS for technological teaching in our department. Section II describes the study of using the LMS for sharing course materials and make bi-directional feedback/assessment in a technological common core (general education) course. Meanwhile, Section III describes the study of using the LMS for management of laboratory activities in a general engineering course. In addition, Section III describes how a Wiki-based forum service can be used for communications between instructors and students.

II. LMS FOR SHARING OF CONTENTS/IDEAS AND ASSESSMENT IN A GENERAL ENGINEERING COURSE

Everyday Computing and the Internet (CCST9003) is a common core (general education) course first offered in 2010 by the Department of Electrical and Electronic Engineering [13]. Besides introducing to students a “computational thinking” concept through twelve-weeks teaching, CCST9003 also discuss intensively the societal impacts of computing technologies on our daily life, through surveying of computational methods and analysing usage of computational methods.

We have used the LMS as a complementary tool to share/distribute course materials and ideas in Fall Semester 2012. Sample views of the constructed course page is shown in Fig. 1. Through the LMS, students can learn and assess asynchronously, anytime and anywhere. In addition, LMS was used to reduce instructors' workload by the job automation of assessment and administration. For example, students can attend a quiz several times without increasing instructor's workload. In addition, quizzes can also be automatically generated and marked through the constructed question bank.

A. Role of students and teachers

Through the system, students can:

- View and download course content, such as handout, presentation slides, video clips, follow-up of discussions and project reports (survey and critique);
- Read suggested readings through external links;
- Do online quizzes (homework) and self-reflection exercises;
- Upload digital course assignments (e.g. digital documents, audio and video clips);
- Conduct survey for the course evaluation;
- Share content and messages through internal messaging and course forum.

Meanwhile, through the system, instructors and teaching assistants can:

TABLE I
USAGE STATISTICS OF CCST9003.

Resource	Page view	Page view per student
Quiz/Homework	6639	46.43
Project	3628	25.37
Forum	1927	13.48
Handout	1720	12.03
Video	529	3.70
Others	2723	19.04

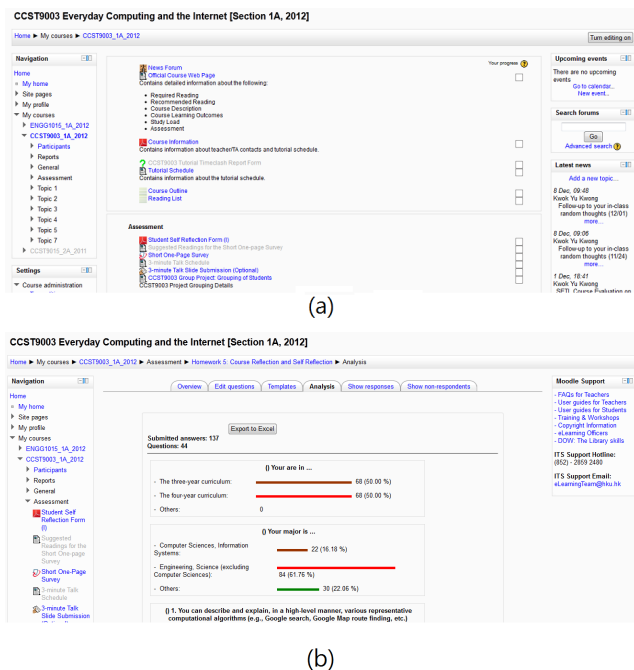


Fig. 1. Sample views of the course page for CCST9003. (a) Course page; (b) Analysis of student's self-evaluation.

- Develop instructor-constructed content, such as handouts, random thoughts (discussions of muddy questions), follow-up of discussions, probing questions and guidelines of tutorials;
- Participate students' discussions and answer questions from students;
- Design online quiz and assignments as well as construct question banks;
- Grade and give comments on quiz and assignments as well as analyse quiz results;
- Collect comments from online (anonymous) survey for the improvement of the course;
- Examine the originality of students' assignments via the plagiarism checking service (e.g. Turnitin).

B. Tools evaluation

1) *Usage statistics:* Table I shows the usage statics of the course page. Statistics show that the Moodle course page provides a prompt and convenient channel for sharing of materials, videos and ideas, as well as giving feedback, doing quizzes and having discussions. In particular, statistics show that students had attempted every quiz a few times. Therefore, students consolidated their knowledge through a repeated answering process. In conclusion, the LMS serves its purpose of sharing of ideas and course contents as well as reducing instructors' workload.

2) *Student questionnaire:* A total of 137 students participated in the end-of-semester survey resulting in a response rate of 95.80%. Data from Likert-type questions in Table II indicate that LMS is generally efficient for downloading/uploading course materials as well as conducting assessments. Moodle can significantly enhance the efficiency and perception of learning via quick and simple implementations.

Besides quantitative data, we also collected open-ended feedback. Overall, responses were positive. Many students

acknowledged the benefits of using LMS (Moodle) in distributing and collecting materials, e.g.:

- *“Moodle is very useful that integrate different assess of courses through a single platform. I can download the notes and read the latest information easily through any device with internet connection. Also, I can submit my homework anywhere and anytime. It is more time-saving and environmentally-friendly as no hard copy of homework is submitted. Also, the Moodle allows students to revise their homework before due date of homework. It is true that modification of document in a computer is always easier than in a paper work. Furthermore, we can upload video, powerpoint, etc. This saves our time to go back school to submit our homework.”*
- *“Moodle is a very good platform for lecturer to distribute course materials, give comments and share news to students.”*
- *“The learning system is quite good. I could easily read the uploaded materials and download it quickly. And the teacher have actively use this system and has provided us enough resources, not only lecture slides as well as suggested solutions for the tutorial problems, but also interesting and inspiring videos about Computing and Internet, to learn the topic well.”*
- *“The user friendliness is generally acceptable, quite convenient to integrate with the Turnitin system. Yet, uploading large files such as videos can cause many troubles as no upload process bar is shown.”*

From received questionnaire, we can observe that most students enjoyed online learning experience via the interactive and centralized LMS.

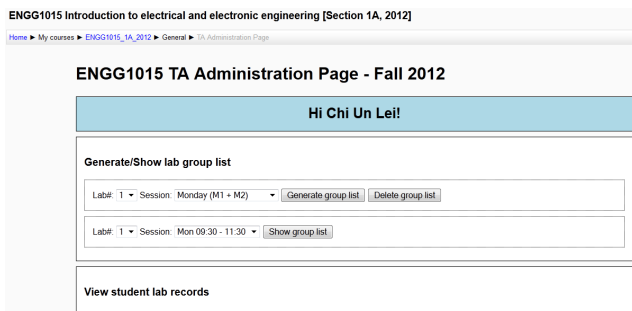
On the other hand, some students worried about the applicability and functionality of the system in different electronic devices. Examples of negative comments are as follows:

- *“(There is) no mobile version. Even on desktop, the layout requires lots of scrolling. Complicated folder structures. (I) cannot create shortcuts. (There are) no search function for lecture notes and assignments. Online file system lacks basic sorting, upload time information, and more advanced HTML5 drag-and-drop download support. Most importantly, (the system) is completely isolated from (the) school portal.”*

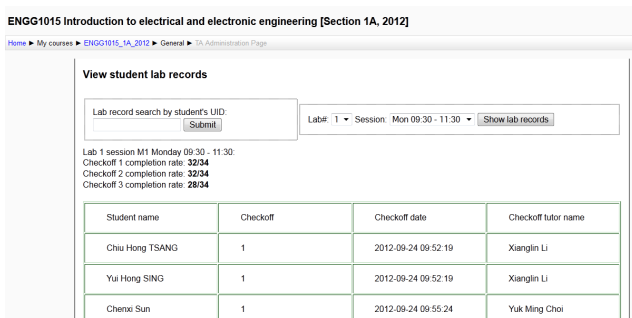
In the future, we will explore feedback techniques which are more complex but result in deeper and more complete feedback.

TABLE II
NUMBER OF STUDENTS WHO INDICATED AGREEMENT-DISAGREEMENT IN THE SURVEY (1=STRONGLY DISAGREE, 2=DISAGREE, 3=NEUTRAL, 4=AGREE, 5=STRONGLY AGREE).

Survey item	1	2	3	4	5	Mean score
1. The course has actively used Moodle for teaching and learning.	0	0	11	67	58	4.35
2. Moodle is effective to download course-related videos, notes and other materials.	1	4	15	55	61	4.26
3. Moodle is effective to upload course-related videos, assignments and other materials.	2	6	17	65	46	4.08
4. Moodle is effective to conduct assessment activities (e.g. homework/quiz/feedback).	1	2	15	71	47	4.18
5. I can read the course materials in Moodle asynchronously, anytime, anywhere.	1	9	20	65	41	4.00
6. The Moodle system is student-centered.	2	3	29	73	29	3.91
7. The Moodle system is easy to manage.	5	5	25	66	35	3.89



(a)



(b)

Fig. 2. Sample view of the course page for ENGG1015. (a) Group administration; (b) Attendance administration

III. LMS FOR LABORATORY MANAGEMENT IN AN INTRODUCTORY ENGINEERING COURSE

Introduction to Electrical and Electronic Engineering (ENGG1015) is a general engineering course first offered in 2010 [14]. Besides introducing to students the world of electrical and electronic engineering through twelve-week lectures, it also includes an integrated project to develop student's indispensable skills as an engineer. The course consists of 32 two-hour laboratory sub-classes.

Based on the experience in previous years, we decided to minimize instructor's workload in managing laboratory activities. Therefore, we developed a LMS toolbox to manage laboratory activities. In other words, an external database system had been designed for the LMS. A sample view of the constructed page is shown in Fig. 2.

A. Role of students and teachers

Through the system, instructors can:

- authenticate the completeness of students' activities via scanning of matrix (2D) barcodes;

TABLE III
USAGE STATISTICS OF ENGG1015.

Resource	Page view	Page view per student
Homework	7923	51.45
Handout	2421	15.72
Forum	346	2.25
Others	3910	25.40

- check, add, delete and update records of students' activities;
- instruct the system to automatically arrange students' partners, schedules, equipment and benches;
- assign roles and permissions for teaching assistants;
- distribute worksheets and other digital contents.

Meanwhile, through the system, students can:

- enroll for laboratory activities;
- download instruction sheets and materials;
- conduct performance assessment of laboratory activities within the assigned time period.

B. Tool evaluation

A survey analysis was done to evaluate the effectiveness of using LMS for managing laboratory activities. The class that we studied consists of 154 students. In the questionnaire, we have posed Likert-type statements. In total, 123 students completed the survey resulting in a response rate of 79.87%. Table IV shows the score distribution and the mean score that we have obtained on each of the statements. As can be seen, students agree that the developed platform provides an effective channel for the management of laboratory activities. This can be also proved by the usage statistics shown in Table IV.

Besides quantitative data, we have also collected open-ended feedback. Overall, responses were positive. Students acknowledged both benefits and limitations of using LMS for management of laboratory activities, e.g.:

- "Moodle has been really helpful as it allows us to access notes and slides on the go."
- "(The platform is) User-friendly and function(s) properly."
- "Moodle is good in PC but tablet cannot function well in downloading notes thought moodle via iPad."

IV. WIKI-BASED FORUM SERVICE FOR COMMUNICATIONS IN A GENERAL ENGINEERING COURSE

Based on the experience of adopting social networking services for teacher-student communications in ENGG1015 [8],

TABLE IV
NUMBER OF STUDENTS WHO INDICATED AGREEMENT-DISAGREEMENT IN THE SURVEY (1=STRONGLY DISAGREE, 2=DISAGREE, 3=NEUTRAL, 4=AGREE, 5=STRONGLY AGREE).

Survey item	1	2	3	4	5	Mean score
1. The course has actively used Moodle for teaching and learning.	3	11	29	41	39	3.83
2. Moodle is effective to download course-related materials.	2	7	22	46	46	4.03
3. Moodle is effective to upload assignments and other materials.	4	10	17	41	51	4.01
4. Moodle is effective to conduct assessment activities (e.g. lab assessment).	0	15	14	50	44	4.00
5. I can read the course materials in Moodle asynchronously, anytime, anywhere.	4	9	21	43	46	3.96
6. The Moodle system is student-centered.	2	7	26	53	35	3.91
7. The Moodle system is easy to manage.	1	7	28	48	39	3.95

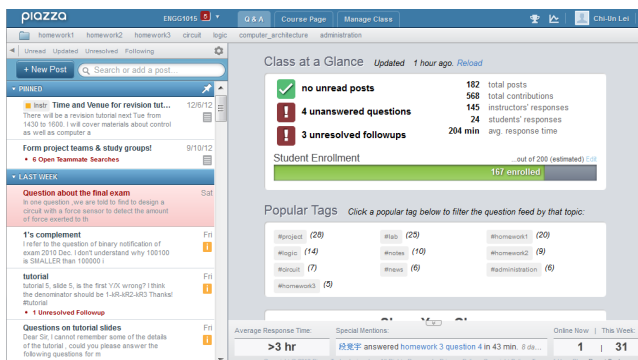


Fig. 3. Sample view of the course Piazza Page for ENGG1015.

we have adopted a Wiki-based forum service, Piazza, as a prompt and convenient channel to announce course news and stimulate students' discussions. In the forum, students and instructors can ask questions, answer questions, and edit/update their responses. It is also convenient to use LaTeX-based editing; therefore, the service is applicable for discussions in scientific courses. A sample view of the constructed page is shown in Fig. 3.

A. Role of students and teachers

Students can use the forum for the following purposes:

- raise questions about the course;
- discuss interactively and friendly with instructors and classmates by answering questions from peers and participating polling;
- obtain the most updated information about the course.

Meanwhile, instructors can use the course forum for the following purposes:

- provide prompt solutions to students about learning activities and assignments;
- announce news about course administration, lectures, laboratory sessions, tutorials and homework.

B. Tool evaluation

The forum had been used for one semester (i.e. three months). During the evaluation, there were 567 contributions, including posts, responses, edits, follow-ups and comments. Among those contributions, students have asked 131 questions. 95% (145) and 15% (24) of questions received responses from instructors and students, respectively. Results show that there was a moderate communication and collaboration across the forum. Therefore, it serves its purpose of communication and collaboration. In the future, we will

continue to fully utilize the service, such that students feel more convenient and open to use the forum for questioning, communications, discussions and collaborations.

V. CONCLUSION

In this paper, we have evaluated the effectiveness of using LMS in the teaching of two technological courses. The received evaluation shows that LMS acts as an efficient channel for sharing of ideas and materials, as well as conducting assessments asynchronously, anytime, and anywhere. Furthermore, LMS can also reduce instructors' workload by the automation of assignment marking and activity managing.

Results of the study can be extended to several directions, namely:

- mobile learning and social networking;
- teaching and learning via microblog;
- Web 3.0 tools (e.g. augmented reality, semantic web) for education.

ACKNOWLEDGMENT

We are grateful to Prof. Y.K. Kwok, Dr. K.H. So, Dr. K.Y. Wong and Dr. Y. Lam for their preparation of CCST9003 and ENGG1015.

REFERENCES

- [1] R. Drira, M. Laroussi, X. Pallec, and B. Warin, "Contextualizing learning scenarios according to different learning management systems," *IEEE Trans. Learning Technol.*, vol. 5, no. 3, pp. 213–225, Sep. 2012.
- [2] K. Martin, M. Quigley, and S. Rogers, "Implementing a learning management system globally: An innovative change management approach," *IBM Systems Journal*, vol. 44, no. 1, pp. 125–145, Apr. 2005.
- [3] S. Rapuano and F. Zoino, "A learning management system including laboratory experiments on measurement instrumentation," *IEEE Trans. Instrumentation and Measurement*, vol. 55, no. 5, pp. 1757–1766, Oct. 2006.
- [4] C.-U. Lei, "Applying the problem-based learning approach in teaching digital integrated circuit design," in *Proc. Enhancing Learning Experiences in Higher Education: Int. Conf.*, Dec. 2010, pp. 1–5.
- [5] C.-U. Lei, H. K. So, E. Y. Lam, K. K. Wong, R. Y. Kowk, and C. K. Chan, "Teaching introductory electrical engineering: a project-based learning experience," in *Proc. IEEE Intl. Conf. on Teaching, Assessment and Learning for Engineering*, Aug. 2012, pp. 335–339.
- [6] C.-U. Lei, N. Wong, and K. Man, "Integration of a wireless sensor network project for introductory circuits and systems learning," in *Proc. IEEE Int. Symp. on Circuits and Systems*, May 2013.
- [7] "Official website of Centre for Information Technology in Education, Univ. of Hong Kong." [Online]. Available: <http://www.cite.hku.hk/>
- [8] C.-U. Lei, T. Krilavicius, N. Zhang, K. Wan, and K. Man, "Using web 2.0 tools to enhance learning in higher education: A case study in technological courses," in *Proc. IAENG Intl. MultiConf. of Engineers and Computer Scientists*, Mar. 2012, pp. 1153–1156.
- [9] "Official website of eLearning Pedagogical Support Unit, Univ. of Hong Kong." [Online]. Available: <http://epsu.cetl.hku.hk/>

- [10] C.-U. Lei, J. Seon, Z. Shen, K. Man, D. Hughes, and Y. Kim, "Building a laboratory surveillance system via a wireless sensor network," in *Proc. Intl. Conf. on Grid and Pervasive Computing*, May 2013.
- [11] S.-T. Fung, V. Tam, and E. Y. Lam, "Enhancing learning paths with concept clustering and rule-based optimization," in *Proc. IEEE International Conference on Advanced Learning Technologies*, Jul. 2012, pp. 249–253.
- [12] V. Tam, J. Yeung, E. Y. Lam, and C.-H. Leung, "Developing an innovative and pen-based simulator to enhance education and research in computer systems," in *Proc. IEEE International Conference on Advanced Learning Technologies*, Jul. 2009, pp. 267–269.
- [13] "Official website of CCST9003." [Online]. Available: <http://www.eee.hku.hk/~ykwok/CCST9003/>
- [14] "Official website of ENGG1015." [Online]. Available: <http://www.eee.hku.hk/~engg1015/>