

## **‘Make-It-ECE’, a Mathematics Learning Management System (LMS) for Engineering Students in the Philippines**

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## ABSTRACT

Make it EC-E (MiE) is a learning management system (LMS) designed to supplement the mathematics review of candidate engineers for National Licensure Board examination in the Philippines. The content of the LMS is based on an ABET-certified curriculum. Its design is made simple as possible and it features gamification of learning activity. The game of choice is lottery using virtual play money. The randomness of lottery is to be beaten by the degree of knowledge acquired. The system collects student performance data in a well-defined database structure that facilitates test question reconstruction. Test question reconstruction is intended for adaptability of system according to teacher's assessment of current weaknesses of the students. The acceptability of MiE is determined through survey however its effectiveness remains to be confirmed from actual result of the board exam.

## KEYWORDS

learning management system, gamification, engineering education, teaching mathematics, on-line teaching tools

## 1. INTRODUCTION

In the Philippines, based on our survey the most commonly used LMS in higher education are open-source softwares. For engineering review centers, their LMS-based engineering tutorials have restricted access since these are part of the paid package by the students.

The "Make-it-ECE" (MiE) was developed as an open-source learning management system (LMS). It is a supplement of mathematics review for engineering national licensure board exam. A group of examinees were selected randomly from 4<sup>th</sup> and 5<sup>th</sup> year Electronics Communication Engineering (ECE) students of the Technological Institute of the Philippines (TIP) for alpha-site testing. Since TIP ECE program is an ABET-certified program, its curriculum was made as the basis of the contents for this LMS.

MiE is intended to address the difficulties of engineering students from TIP in mathematics to pass the board exam despite of the availability of sufficient number of review materials. The software features gamification in terms of playing a lottery game to navigate through the different topics. We conducted a survey among ECE students, lecturers and engineering education experts and the results were processed based on a previous work (Naidu, 2006).

A challenge of LMS learning curve is the learning of the system itself and, thereafter, the learning process of the content. The graphic-user interface engagement in MiE is highly intuitive. Hence, the user interaction was designed as simple as possible.

In this paper, we present a brief literature review, a discussion of the LMS architecture and design, and its validation. Based on our surveys, our LMS is useful and practical, while its effectiveness as a mathematics review tool remains to be confirmed.

To our knowledge, MiE is a pioneering open-access LMS in the Philippines. As of this writing, there is another local LMS, pinoyboardexam.com, which is being developed for the crowd-sourcing for tips and board exam questions.

## 2. LITERATURE REVIEW

E-learning is gaining widespread use among academic institutions as an alternative to traditional classroom teaching (Hameed, 2008). Online-based teaching strategies have the advantage of facilitating teaching and instruction regardless of the geographic location, availability of classrooms and formal class schedules (Rennie, 2003). From a business perspective, it is also marketable as an education app, product or service suitable for 'technology-savvy' students (Bates, 2005).

A software tool for e-learning system is also termed as learning management system (or LMS) (Nichols, 2003). The system is being developed to fill-in gaps in students' learning outcome needs. LMS can be utilized by teachers to create, administer, and manage their online courses; and it also incorporates features for tracking and managing a variety of student data, especially that of performance (Graf, 2007).

There are two categories of LMS: open source and commercial. An open source is a software that is freely accessed, shared, modified and/or re-distributed (Karl, 2005). The most common open-source LMS is Modular-Object Oriented Dynamic Learning Environment (MOODLE). It uses software packages to help educators create quality online instructions allowing for an interactive teaching environment. It can be a stand-alone package or supplemented with conventional classroom instructions.

Blackboard is an example of a popular commercial LMS. This virtual learning and course management environment is web-based with features of open architecture and scalable design allowing integration with student information systems and authentication protocols (<http://www.blackboard.com>). However, a main constraint with commercial versions is affordability because the license-for-use is typically renewed annually. The use therefore of commercial LMS is limited in learning institutions in developing countries (Grob, 2004; Pankaja, 2013).

Granted that a majority of students usually spend a considerable amount of time playing video games, schools may as well explore the use of games on their LMS to incorporate an element of entertainment in their learning process (Whitton, 2010). An example of such software is *Cool It* developed at the Department of Mechanical Engineering, University of Wisconsin-Madison, to teach cryogenics to engineering students ([http://engage.wisc.edu/sims\\_games/roundtwo/awardees/cool\\_it/index.html](http://engage.wisc.edu/sims_games/roundtwo/awardees/cool_it/index.html)) (Johnson, 2011). MOODLE also contains gaming functions, such as *Hangman*, *Crossword*, *Sudoku*, and *Hidden Picture*. There is also a mathematics learning game such as *Math Blaster* created at the University of Washington to help practice college students with algebra problems ([www.knowledgeadventure.com](http://www.knowledgeadventure.com)) (Rodrigo, 2011). Assuming students can better meet a desired learning outcome through motivation to win in a game, early developers have also used lottery as a teaching device. With *Tac-Soft Quiz Maker*, a commercial LMS that helps teachers create tricky examination questions, the system automatically generates multiple choice questions in the format of a lottery ([www.tac-soft.com/](http://www.tac-soft.com/)).

## 3. ARCHITECTURE AND DESIGN OF THE LMS

The architecture was the first consideration in the design of MiE. Three layers were identified to be the user interface layer, application layer and data storage layer according to the previous studies (AL-Mukhtar, 2012).

The operation MiE with the student user is shown in Figure 1A. It requires internet connection with typical support application software for the browser. There is no need for application software download since MiE is website-based ([www.makeitece.ictsecurity.org](http://www.makeitece.ictsecurity.org)).

The browser is the graphic user interface (GUI) for both the students and the teacher. The design considerations for GUI are defined by the following guidelines:

- a) Use of relevant hyperlinks (e.g. do the hyperlinks match with the content?)
- b) Lay out of the figures (e.g. are the images accompanying the lectures are visibly placed in page?)
- c) Reward and penalty of the lottery function (e.g. is the money prize properly accounted based on correct/incorrect answers?)
- d) Real-time feedback (e.g. do student's rating scores appear every time the exam is finished?)

The architecture is shown in Figure 1B. The front end is GUI for both the students and teacher. The website consists of Lecture Notes (LN), Learning Activities (LA), Assessment Exam (AE), Forum and Login/Logout History. The LN is predefined by content of ABET-certified ECE subjects. The content of the LN are based on the math courses of ECE curriculum at TIP which include trigonometry, geometry, calculus, differential equation and algebra.

LA are pre-defined by the lottery game software (Figure 2A). Java script and HTML were used. The player could earn or be penalized depending on the response to a set of questions. In every event of challenge to answer a question, the result of a response was immediately reported. Hence, the feedback mechanism is real-time.

The mechanics of the lottery game is discussed as follows:

The students need to first select the subject in order to play the lottery. Each subject is composed of multiple choice questions. Every question that appears on the screen is randomly selected by the system. Once the subject is selected, the student can play the lottery by clicking the "click here" button. An initial capital of P 5000 (USD=110) is allotted to the students once the game is played for the first time. For every question, there is a corresponding amount of "cash" that is either added to (for correct answers) or deducted (for wrong answers) from the capital. Bankruptcy will automatically terminate the game. The student can use the following options only once during the game: (1) "50-50" risk: the monetary value of the question is reduced by 50%, (2) switch questions: another question is displayed, and (3) hint button: a clue will be provided to help answer the question. The keys for these functions are seen in the lower panel of the screen (Figure 2A). In order to win the game, the student has to complete all the questions without getting bankrupt. The game is usually played within an hour per subject.

Only the teacher has access to Login/Logout History. The data from AE, Forum and Login/Logout History are supported by My-Sql database.

The assessment exam (AE) provided platform for the teacher to delete, construct or modify questions. A sample question page in the Assessment Exam (AE) is shown in Figure 2B. Depending on the instructor, the students are given time limit to complete the set of questions. All answers to the questions are in multiple choices. Exam data are collected and analyzed. The results

determine the nature of new set of questions that address the current weak performance of the examinees.

The data from the Forum serves as additional information for the analysis of assessment results. It may serve as validation of the analysis. It serves also as the venue for bug reporting. It is coded using PHP. Data from Forum consist of title, author, number of replies, date and time of posting. The Forum provide a venue students to express themselves in a manner that they could not do so in a classroom setting (Cole, 2008)

The statistics of Login/Logout history could be an indicator of usage demand of the system. MiE is password protected. Students can subscribe by contact the teacher or administrator through Facebook or an email portal. The Facebook account and email address of the administrator can be seen on the login page. The username and password are both defined during registration.

#### 4. VALIDATION

Validation of the MiE alpha-site was conducted during the Academic Year 2013/2014 to students in their 4<sup>th</sup> and 5<sup>th</sup> year of Bachelors of Science in ECE at the Technological Institute of the Philippines (TIP). The study population comprises of 18 male and 7 female with an age range 19 to 21 yrs.

Nine engineering instructors evaluated the software for its usability, adaptability and overall satisfaction. Six of the instructors are faculty members of TIP-Quezon City campus. Of these, 5 instructors are from ECE department and 1 from Electrical Engineering (EE) department. There are 2 ECE instructors from TIP-Manila campus and 1 from Far Eastern University. The instructor respondents have more than a year of teaching experience in engineering.

MiE was evaluated by 3 engineering education experts in terms of the content and suitability as a mathematics reviewer for the national licensure board examinations. The experts are all professors in mathematics and engineering and they occupy top management positions in the university for more than five years with substantial industry linkages.

The instruments used in this study were the questionnaire for students and teachers, and scheduled interviews with engineering education experts.

A questionnaire using the 5-point Likert scale answerable within 5 minutes was adopted. It determined the respondents' perceptions on the different modules of MiE. Responses under each item consist of 'strongly agree', 'agree', 'neutral', 'disagree', and 'strongly disagree'. The 5-point score was assigned to answer 'strongly agree' at positive items, and 1-point score was assigned to answer 'strongly disagree' at negative meaning items.

The satisfaction or perception survey on LN, LA, and AE were given to students. The satisfaction survey on usability and adaptability were given to teachers. The instrument design was adopted from the works of Al-sarravrih (Al-sarrayrih, 2010).

#### 5. RESULTS AND DISCUSSIONS

The data of student perception of MiE is plotted in Figure 3. Based on the survey, the students were generally satisfied with the system with LN getting the highest score at  $4.3 \pm 0.6$ . There was no significant difference ( $p= 0.871$ ) among LN, LA and AE. It appeared that the motivation factor anticipated from the lottery game in LA did not have substantial impact on student learning

outcomes. This was attributed to the fact that our students were already motivated from the beginning to pass the licensure examination.

Another method to measure the effect of gaming on student motivation to learn was based on the number of students who participated in an activity, percentage of the students who completed an activity, and the average of response time to questions in an activity (Dominguez, 2013). These parameters will be explored in a future study.

There were 9 responses from engineering teachers who evaluated our LMS. The perception on LN, LA, and AE in terms of ease-of-use (E), material adaptability (A) and overall satisfaction (S) were plotted in Figure 4. Assessments were also based on the 5-point Likert scale. The results indicated that majority of the teachers were generally satisfied with all the 3 parts of the LMS. LN obtained the highest score in terms of ease-of-use with the mean value of  $4.3 \pm 0.5$ . AE scored highest on material adaptability with the mean of  $4.2 \pm 0.7$ . No significant difference was found with ease of use ( $p= 0.352$ ), adaptability ( $p=0.523$ ) and overall satisfaction ( $p=0.938$ ) for LN, LA and AE. Additionally, the teacher respondents liked the idea of the lottery game. They also cited the benefit for the student to get immediate feedback on performance in the AE.

Finally, based on our interviews of 3 engineering and education experts, the common comment was that the content was “sufficient, clear, and accurate.” The experts also provided specific recommendations for additional topics in geometry, increased number of difficult problems in LA, and correction of typographical errors.

## 6. CONCLUSION

MiE has been demonstrated to be usable as possible supplement for mathematics review by prospective examinees of national board examination in engineering. The LMS design is shown to be simple but sufficient enough for intuitive user-interaction.

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## REFERENCES

- AL-Mukhtar, M. H., Sarmad. (2012). Developing a Three-Tier Web Data Management Application for Higher Education Admission Environment. *International Arab Journal e-Technology*, 2(4), 175-180.
- Al-sarrayrih, K., L, et. al. (2010). *Evaluation of a Moodle Based Learning Management System Applied at Berlin Institute of Technology Based on ISO-9126*. Paper presented at the ICL2010, Hasselt, Belgium.

- Bates, T. (2005). Emerging trends: convergence and specialization *Technology, E-Learning and Distance Education* (2nd ed., pp. 10). New York: Routledge's.
- Dominguez, A., Saenz-de-Naverette, J., et.al. (2013). Gamifying Learning Experiences: Practical Implications and Outcomes. *Computers & Education*, 63, 380-392.
- Boticki, I., Budiscak, I. & Hoic-Bozic N. (2008). Module for Online Assessment in AHYCo Learning Management System. 38(2), 115-131.
- Cole, J. F., H. (2008). *Using Moodle - Teaching with the Popular Open Source Course Management System* (2nd ed.). USA: O'Reilly Media, Inc.
- Rennie, F. (2003). The Use of Flexible Learning Resources for Geographically Distributed Rural Students. *Journal of Distance Education*, 24(1), 25-39.
- Graf, S. (2007). *Adaptivity in Learning Management Systems Focussing on Learning Styles*. (Information System), Vienna University of Technology. Retrieved from <http://www.big.tuwien.ac.at/staff/sgraf.html>
- Grob, H., Bensberg, F, & Dewanto, B. (2004). Developing, Deploying, Using, and Evaluating an Open Source Learning Management System. *Journal of Computing and Information Technology*, 127-134.
- Hameed, S. C., A.J. (2008). *Effective E-Learning Integration with Traditional Learning in a Blended Learning Environment*. Paper presented at the European and Mediterranean Conference on Information Systems, Al Bustan, Dubai.
- Karl, F. (2005). Producing Open Source Software. *Introduction* (First ed., pp. 12.). Sebastopol: O'Reilly Media Inc.
- Johnson, L., Brown, M., et. al. (2011). *The Horizon Report: The New Media Consortium*.
- Pankaja, N., Mukund Raj, P. K. (2013). Proprietary Software vs. Open Source Software for Education. *American Journal of Engineering Research*, 2(7), 124-130.
- Naidu, S. (2006). *E-Learning: A Guidelines of Principles, Procedures, and Practices* (2nd Edition ed.). New Delhi: Commonwealth Education Media Center for Asia (CEMCA).
- Nichols, M. (2003). A Theory for eLearning. *International Forum of Educational Technology & Society*, 6(2), 13.
- Whitton, N. (2010). *Learning with Digital Games*. Madison Ave.: Routledge.
- Rodrigo, M. M. (2011). Dynamics of Student Cognitive-Affective Transitions During a Mathematics Game. *SAGE*, 42(1), 85-99.

FIGURE 1. The Architecture of the LMS (A) The front-end interface architecture and (B) The front-end and the back-end architecture of the LMS

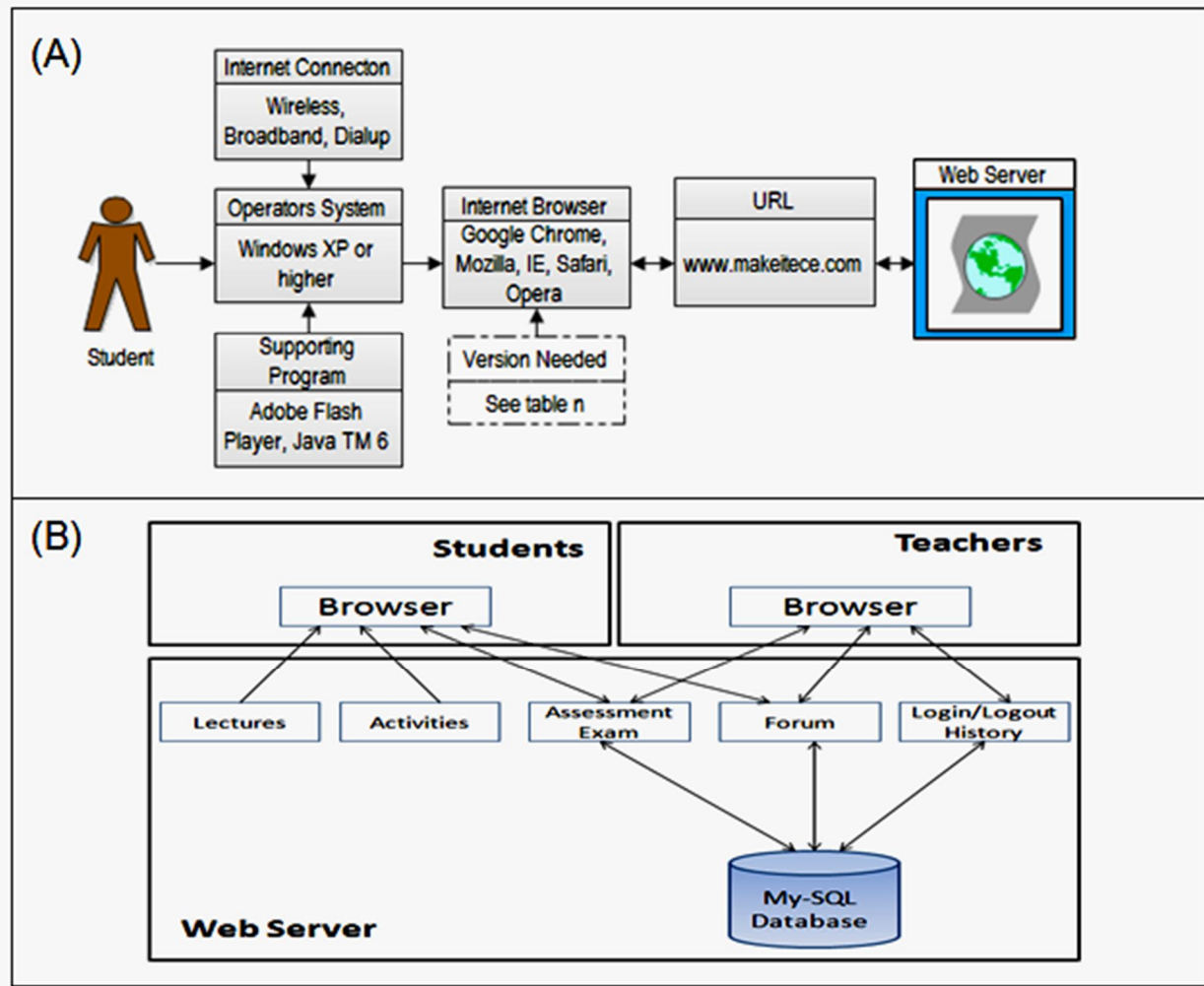




FIGURE 2. Screenshots of MiE. (A) Lottery Page (B) AE Page

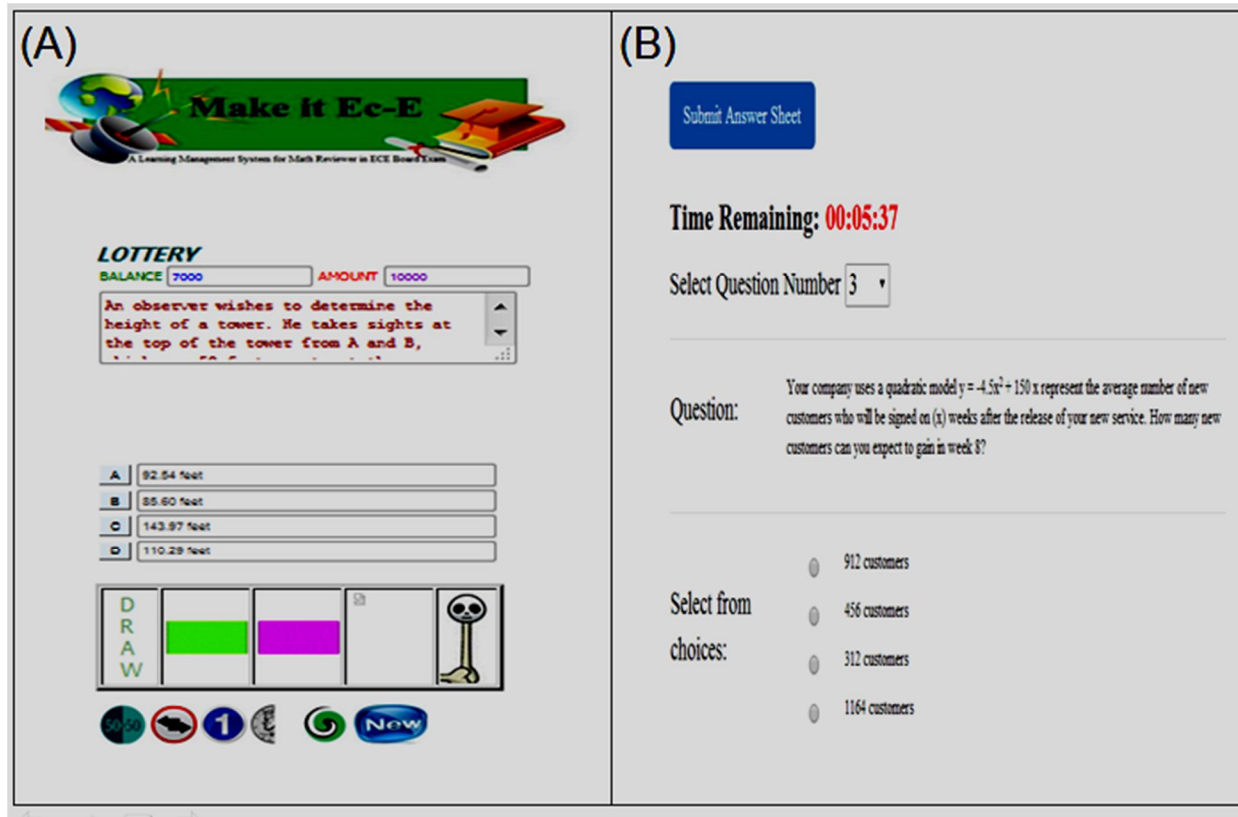


FIGURE 3. Student evaluation of the lecture notes (LN), lecture activities (LA) and assessment exam (AE) based on 5-point Likert scale.

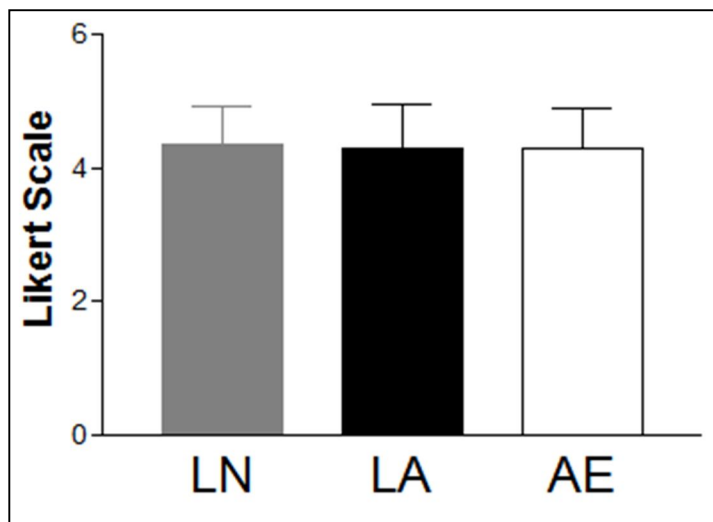


FIGURE 4. Average rating scales of engineering teachers on the lecture notes (LN), learning activities (LA) and assessment exams (AE). Shown are the scores in terms of ease-of-use (E), material adaptability (A) and overall satisfaction (S).

