Evaluating and Adopting e-Learning Platforms

Richard W. C. Lui, Kendra K. Y. Lo, and S. M. Yiu

***Abstract*—This paper aims to propose a framework for classifying and analyzing e-Learning platforms from the infrastructure, functions, specialization, learning activity, learning context, learning experience and customization dimensions. The framework is used to classify and evaluate a number of existing mathematics e-Learning platforms.**

***Index Terms*—E-learning adoption, e-learning classification, mobile learning.**

I. Introduction

The prevalence of Internet and the increased availability of computers and mobile devices result in an explosive growth of studies in e-Learning and mobile learning. The advantages of e-Learning have been extensively studied in different academic disciplines (e.g. [1]–[8]).

The Government of the Hong Kong Special Administrative Region (HKSAR) has given impetus to introduce e-Learning. In 2010, a Pilot Scheme on e-Learning in Schools has been launched by the Working Group on Textbooks and e-Learning Resources Development to investigate, develop, try out, evaluate when and how e-Learning could be implemented in different schools and subject curriculum. Various degrees and approaches of adopting e-Learning could be found. For instance, Tai Po Old Market Public School (Plover Cove) introduced the use of Learning Management System for managing and supporting lessons. St. Edward's Catholic Primary School has started the implementation of e-Learning by developing a virtual game learning community, adventure games and consolidation exercises to motivate the students to apply and practice knowledge that they have learnt in classes. Many other schools have also adopted e-Learning in their own ways.

Because of the wide varieties of e-Learning platform and adoption approaches, numerous models for classifying e-Learning platform have been proposed (e.g. [9]–[13]). Different studies focus on different aspects of e-Learning, including the underlying technology [9], system features [10] – [13] and supported learning activities [11], [13]. However, the user perspective (e.g. learning experience, customization), adoption approaches (e.g. how they can be used in teaching and learning) and the learning context has been neglected. Also, the existing models make use of different terminology and characterize e-Learning systems at different levels of abstractions. It is not easy to compare and integrate the different models for evaluating e-Learning platforms.

Manuscript received March 11, 2013; revised June 20, 2013.

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In this paper, we propose a framework for analyzing, evaluating and adopting e-Learning platforms from the following dimensions: Infrastructure, Functions, Specialization, Learning Activity, Learning Context, Learning Experience and Customization. The framework provides guidelines for teachers and schools to evaluate, select and adopt e-Learning platforms. It can also be used by software developers to design appropriate educational platform in different context.

This paper is organized as follows. In section 2, the related research will be outlined. In section 3, our interaction model for e-Learning will be described. In section 4, a framework for evaluating e-Learning systems will be proposed for evaluating existing mathematics e-Learning platforms. In section 5, the summary and future work will be described.

II. Related Research

Naismith [14] classified the mobile technology by two orthogonal dimensions, portability (from portable to static) and personality (from personal to share). Hrastinski [15] classified e-Learning as asynchronous or synchronous. Georgieva [10] proposed criteria for classifying mobile learning systems: type of mobile devices, communication between students and teachers, communication technology, access to learning materials and administrative services, location of users, support of e-Learning standards and type of supported information. The classification was used for the comparison analysis of mobile learning systems [16].

Horton [13] defined learning objects as “a chunk of electronic content that can be accessed individually and completely accomplishes a single learning goal and can prove it”. Churchill [11] suggested that learning objects are designed for educational reuse and appear to interactivity represent data, information ideas, knowledge or reality by utilizing different digital media. The existing learning objects were classified as presentation, practice, simulation, conceptual models, information and contextual representation objects. The Centre for Instructional Technology and Development at Southern Alberta Institute of Technology proposed a classification of flash learning objects, which included animations, drag and drops, games, interactive graphics, scenario-based simulations, system simulations, tests or quizzes and tutorials.

Grandgenett [9] proposed the following activity types: consider, practice, interpret, produce, apply, evaluate and create. Different activity types may involve different levels of student engagement and mathematical application. Horton [13] classified learning activities as the absorb-type, do-type, connect-type and test. Naismith [14] structured a higher-level classification for learning activities, which included behaviourist learning, constructivist learning, situated learning, collaborative learning, informal, lifelong learning and learning/teaching support activities.

DOI: 10.7763/IJEEEE.2013.V3.229

Kissane [12] classified the mathematics mobile apps according to their functions and contents, which included graphing, calculator, reference source, measuring, drill and practice. Horton [13] identified functions for collaboration in e-Learning, which included slide shows, e-mail, discussion forums, chat and instant messaging, whiteboards, web tours, application sharing, polls, audio-conferencing, video-conferencing and breakout rooms.

III. Interaction Model for e-Learning

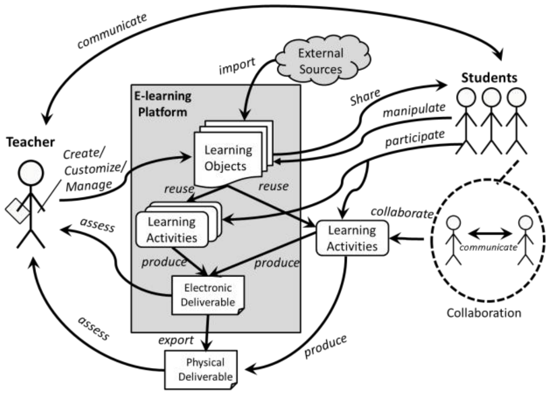

Fig. 1. Users e-learning platform interactions model.

Fig. 1 shows our interaction model for e-Learning platforms. We define *learning objects* as reusable content in electronic format to achieve defined learning objectives (e.g. presentation slides, game, simulation, virtual manipulative). Learning objects can be created from scratch or customized by teachers. The teachers may share learning objects with other teachers through the Internet (e.g. HKedCity EdV Channel, HKedCity Online Question Bank) for reuse in other teaching contexts. A *learning activity* is a series of work or actions (e.g. brainstorming, performing demonstration, taking a test, completing a group project, class discussion) performed by students to provoke a specific learning experience. A learning activity consists of one or more learning objectives, learning objects and the steps involved to achieve the learning objectives. The students can participate in learning activities and make use of the associated learning objects. During learning activities, *deliverables* (e.g. completed assignment, written reports, answered questions, completed activity worksheets) may be created to reflect the students' learning experience. During the learning process, the students may communicate with teacher or other students and collaborate with other students by sharing common learning objects.

Teachers and students can interact through the e-Learning platforms in one or more *learning cycles*. *Assessment* may be carried out during or at the end of the learning cycles, where teachers may make use of students' deliverables to evaluate their learning progress and effectiveness of the learning activities. Customized learning objects and activities can be then be designed for the next learning cycle.

IV. Framework for Evaluating e-Learning Platforms

We analyze e-Learning adoption in six dimensions: Infrastructure, Functions, Specialization, Learning Activities, Customization, Learning Experience, User Experience and Customization, and Learning Context (refer to Fig. 2).

The proposed framework is shown in Fig. 3. E-Learning platforms are built on the top of infrastructure. According to their specialization, the e-Learning platforms may provide different functions to support different types of learning activities. E-Learning may be adopted under different learning contexts, target for different types of students and requires the customization of learning activities/objects.

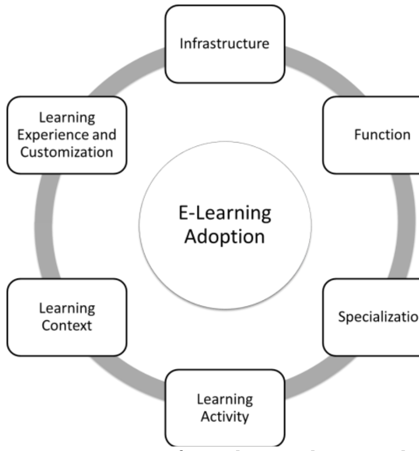

Fig. 2. Dimensions for analyzing e-learning adoption.

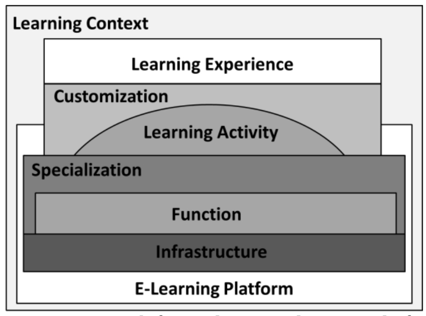

Fig. 3. Framework for evaluating e-learning platforms.

A. *Infrastructure*

E-Learning platforms make use of different devices (e.g. desktop, laptop, mobile devices), network technologies (e.g. WIFI, cellular services) and software platforms (e.g. programming language and model, operating systems, network protocols and services).

B. *Function*

A wide variety of features are available in e-Learning platforms and we classify them into six major functions: Communication, Collaboration, Class Management, Assessment, Learning Activity Management and Learning Object Management.

1) *Communication*

Communication functions support the exchange of information, which include student-student and student-teacher communication. Asynchronous (e.g. email, discussion board) and synchronous communication (e.g. instant messaging, video conferencing) may be supported.

2) *Collaboration*

Collaboration functions (e.g. shared editor, voting, screen sharing) allow the students to cooperate with other students to complete learning activities to achieve a defined goal. For example, e-Learning platforms may support multiple students to interact and work together on learning objects collaboratively (e.g. projects, games).

3) Class management

Class management type functions assist teachers to plan and organize the learning activities. For example, e-Learning platforms may manage the students' profiles, assist the project group formation and submit deliverables such as assignments or group reports online.

4) Assessment

Assessment-type functions assist teachers in evaluating and understanding of students' learning progress. Some systems provide automated marking of the students' answers (e.g. IXL Math, Accelerated Maths), assessment report generation, and allow teachers to provide customized feedbacks online.

5) Learning activity management

Learning Activity Management functions allow teachers to design learning activities by defining the learning objectives, lesson plans, and assigning suitable learning objects to support the teaching activities.

6) Learning object management

Learning Object Management functions allow teachers to create learning objects, distribute learning objects to students, and share learning objects to other teachers. For example, Blackboard allows teachers to design and post multiple choice quizzes online.

C. Specialization

E-learning platforms can be classified according to its specialization (Generic, Generic Educational, and Subject-Based) with focus on different functions (Refer to Fig. 4). Table I illustrates the major functions of e-Learning platforms with different specialization.

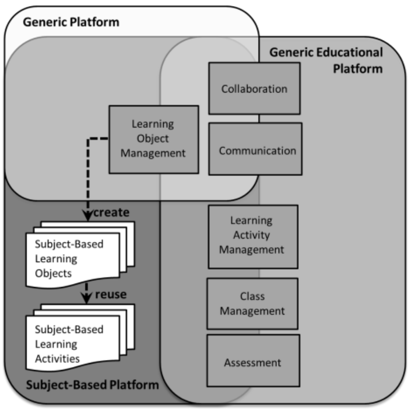

Fig. 4. E-learning platforms with different specializations.

1) Generic platform

Generic Platforms are not designed for educational purposes, but they may provide a subset of learning object management functions by allowing teachers to create and update learning objects. For example, teacher can create lecture notes with Microsoft Word and the students can use Microsoft PowerPoint for presentation. Some web-based generic software support communication-type functions and collaboration-type functions by facilitating the sharing of learning objects. For example, YouTube allows teacher to share videos, to illustrate the steps of calculating multiplication questions and the students may provide comments for the videos. Google Docs allows multiple students to write project reports collaboratively.

TABLE I: EXAMPLE PLATFORMS WITH DIFFERENT SPECIALIZATION

Specialization	Example Software
Generic	- Social Media (e.g. Facebook, YouTube, Twitter); Communication (e.g. Email, Skype), Collaboration (e.g. Dropbox, Google Docs, Wiki) - Authoring Tool (e.g. MS Office, Flash, Prezi, Storybird) - Repository (e.g. Dropbox, Google Drive); Content Management System (e.g. WordPress, Blogger) - Interactive Whiteboard (e.g. The Four-Touch Board, SHARP Interactive Whiteboard)
Generic Educational	- Interactive Whiteboard (e.g. ActivBoard) - Classroom Management (e.g. Blackboard, Moodle) - Repository (e.g. Modern Education Resources Platform, HKedCity Online Question Bank) - Content Management System (e.g. Glogster EDU)
Subject-Based	- On-line Learning objects (e.g. IXL Math, myIT-Farm, onlinestatbook.com) - Games (e.g.My Words Junior, Starwish Little Prince Kinect e-Learning Series, Math Playground) - Educational CD-ROM (e.g. Math Quiz Game Show, Disney's Ready For Math With Pooh) - Mobile Apps (e.g. Math Blitz, Math SpeedCalc) - Simulation (e.g. Wolfram Mathematica, The Math Forum, onlinestabook.com); Virtual Manipulative (e.g. Magic Board, Mult e-Maths, Geometer sketchpad)

2) Generic educational platform

Generic Educational Platforms are designed for educational purposes to support learning activities for different subjects. Most of them provide collaboration, communication, class management, assessment, a subset of learning activity management functions and learning object management functions. However, they provide limited functions for supporting the creation of subject-specific learning objects. In many cases, the teachers can make use of generic platforms (e.g. Microsoft PowerPoint) to create subject-specific learning objects and upload them to the generic educational platform (e.g. HP classroom manager, Blackboard, Moodle).

3) Subject-based platform

Subject-Based Platforms are designed for educational purposes but only focus on a specific subject (e.g. Mathematics). The platforms may support a subset of learning object management (e.g. creation of mathematical models) and assessment functions (e.g. automated marking). For example, the platform may provide a repository of subject-specific learning objects (e.g. National Library of Virtual Manipulative) and functions to facilitate the teachers to create subject-specific learning objects/activities (e.g. Magic Board). Some subject-based platforms also provide communication and collaboration functions.

D. *Learning Activity*

E-learning platforms may provide learning objects or facilitate the creation/customization of learning objects to support different types of learning activities, which range from lower-levels (the students acquires knowledge passively or practice/apply the learnt concepts) to higher-levels (the student should actively explore and create new knowledge). Table II summarizes the four levels of learning activities (from lower to higher levels).

TABLE II: LEVELS OF LEARNING ACTIVITIES

Acquire Knowledge	Learning objects and learning activities present fundamental knowledge directly for students to absorb (e.g. presentation demo, lecture notes).
Practice and Apply	The learning objects and the learning activities are mostly in the form of question set (e.g. quiz papers, drill-and -practice exercises).
Explore and Evaluate	The learning objects and the learning activities are used by students to explore knowledge not yet taught by teachers. The students may take a more active role in the learning process.
Propose and Create	The students have to propose or create a new product, strategy or algorithm during the problem solving process. For example, given a dilemma situation, students have to analyze, make decisions, and proposed possible solutions to solve the problems.

E. *Learning Context*

E-learning systems may be adopted under different learning context. In this paper, we focus on student demographic and learning mode.

1) Student demographic

Students are the most important part in e-Learning. For primary school students who are more attracted to graphics and multimedia, e-Learning systems such as Magic Board and Mult e-Maths are more appropriate as they provide more visual gadgets (e.g. measurement tools for length, angles, weight, checkpoints) to arouse the students' interests. For secondary school students, e-Learning systems such as Geometer sketchpad are more suitable as it provides geometric primitives to allow teachers to easily model and present more complex mathematics concepts.

The motivation of learners can also influence the design of the e-Learning platforms/activities. For passive learner, they might need more interactive and interesting learning activity with wide variety of multimedia. For active learners, exploration and proposing activities may be more suitable.

2) Learning mode

We consider four different types of learning modes. For *classroom learning*, teachers may present using a projector and interactive whiteboard in class. The students may or may not have their own computers. For *cooperative learning*, the students may work in groups to complete learning activities. For example, a group of students may share one laptop computer to observe the results of an experiment or perform an in-class survey with multiple mobile devices. For *distant learning*, the teacher may prepare the learning objects/activities and post them online. The students can access the learning objects or participate in learning activities remotely and learn at their own pace. For *outdoor learning*, the teacher directs the students to learn in real world environment. For example, each student may carry a tablet computer when they visit a stadium, locate the checkpoints, take photos and record their measurements using tablet computers.

F. *Learning Experience and Customization*

The design and functions of e-Learning platforms may bring different types of learning experience. In this paper, we consider the following types of learning experience: interactivity, interestingness, mobility, and customization.

1) Interactivity

Interactive features are the observable change or results after the user has performed actions in the e-Learning platform. It facilitates the students to explore and understand abstract ideas or concepts.

Different e-Learning platforms provide different levels of interactivity. For example, navigation control for learning objects can be provided for students to control their pace and focus of learning. Questions sets can also be included in learning activities to allow the students to provide immediate feedback to their learning processes. Virtual manipulative provide visual representation of dynamic objects and offer an interactive way for students to construct mathematical knowledge [17]. In mathematics teaching, the use of virtual manipulative (e.g. Magic Board, Mult e-Maths) increases the interactivity. For example, students can experiment with different input parameters and observe the effects on the outcome. Table III shows two examples of interactive learning objects.

TABLE III: EXAMPLES OF INTERACTIVE LEARNING OBJECTS

Examples	Description
Geoboard virtual manipulative, available at NLVM (http://nlvm.usu.edu/)	The virtual manipulative allows students to pull the band on the peg and make different shapes on the board by dragging and dropping rubber bands to explore mathematical concepts (e.g. the relationship between area and perimeter).
Onlinestatbook.com (onlinestatbook.com/)	A free online book with interactive demonstrations and simulations, case studies, and an analysis lab.

For mobile learning, the adopted software platform may affect the degree of interactivity. In general, mobile apps provide better interactivity than web-based applications (based on HTML, JavaScript, and Flash). For example, mobile apps may provide features for the students to manipulate/resize/rotate the 2D/3D objects with fingers or by rotating/tilting the mobile devices. However, the apps are often designed for specific mobile platforms (e.g. Android, IOS). Meanwhile, web-based applications can work across multiple platforms but tend to be less responsive to gesture-based interaction.

2) Interestingness

The interestingness of learning objects and learning activities has great influence on the students' learning motivations. For example, the teachers may introduce challenges (e.g. solve puzzles, riddles, and crosswords) and provide rewards for completing different missions. This encourages students to actively participate in the learning activity and develop problem solving skills. Also, the e-Learning systems can incorporate social learning experience so that the students can enjoy spending time in the learning activities by collaborating with others. Teachers can also make use of game creation software (e.g. 2Do It

Yourself) as an incentive for young students to apply mathematics knowledge to construct interesting games.

3) Mobility

Mobility allows users to move freely during the learning activities may improve the students' learning experience.

Device mobility allows users to move around during the learning process. For example, the use of portable (e.g. android tablets) allows users to move freely during the learning processes or participate in outdoor-learning.

User mobility allows users to access the learning objects and participate in the learning activities at multiple places (e.g. home, school, outdoor) by making use of the same or different computers/mobile devices. Students can start a learning activity, suspend it and resume the learning activity at different time/place. User mobility requires the use of cloud-based infrastructure for managing learning objects so that users can access learning objects and participate in learning activities through wired or wireless connections.

4) Customization

Functions should be provided by e-Learning platforms for the teachers to customize the learning objects and activities for students with different demographics and abilities. For example, Wolfram Demonstrations Project provides a pre-defined set of learning objects for visualization and exploration. However, the teachers cannot create new activities or customize existing activities easily. Generic software (e.g. Microsoft PowerPoint, Flash) allows the teachers to create customized learning objects. However, it requires more effort to design interactive learning objects and learning activities. Subject based e-Learning systems such as Magic Board, Mult e-Maths and Geometer Sketchpad allows the teachers to create more interactive subject-specific learning objects and learning activities with minimal technical/programming skills.

V. Summary and Future Research

In this paper, a framework with six dimensions is proposed for evaluating and comparing e-Learning systems. Based on the framework, a number of existing e-Learning systems are evaluated. Our future work is to refine the framework and analyze the relationship between the dimensions. A comprehensive analysis of the existing e-Learning systems will be performed. Also, a roadmap for adopting e-Learning will be developed.

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