Report on the Large-Scale Testing of “Mobile Class”: a Cloud-based Mobile Learning System

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Preface

I am a research fellow at EBTIC, working on the Intelligent Campus (iCampus) initiative, a project that consists of six pillars (iLearning, iSocial, iManagement, iGovernance, iGreen, & iHealth). My focus is on developing the iLearning component, particularly on mobile and cloud learning. The following shows the timeline and activities as included in my fellowship proposal:

| Dec. 1, 2011 to Jan. 16, 2012 | 1) Visit and work on-site at EBTIC (complete literature review on cloud computing, cloud learning, mobile cloud learning, intelligent learning & systems; develop a cloud-based intelligent learning model).  
2) Conduct preliminary testing of the model developed |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>July 8-August 16, 2012</td>
<td>3) Remote large-scale implementation and research (data analysis, report writing); plan for future collaboration</td>
</tr>
</tbody>
</table>

My work at EBTIC comprised 3 main deliverables, which has been completed as part of two visits separated by about 6 months. During my first visit (which lasted 6 weeks), I have completed deliverables 1) and 2). During my second visit, I completed deliverable 3), which is the focus of this report and concerns formal testing of the redeveloped system. For deliverable 3, the “Mobile Class” system was tested with 40 users. What follows is a report on those tests.

Abstract

With the fast development of cloud computing, a number of educational applications that go by names such as the “education cloud” or “cloud learning” have appeared and have become the focus of research. Essentially these terms refer to the integration of cloud computing and learning and are fast becoming significant steps towards establishing an open, flexible learning service platform and in implementing resource sharing. By analyzing the current development of the education cloud, this report presents the structure of a mobile cloud learning platform and associated cloud service functions such as search, learning support, resource retrieval, and learning management.

As stated in my proposal and described in my previous report (Wang, 2012), a testing was conducted on the cloud based mobile learning system--“Mobile Class” during my first fellowship visit. This learning system was built based on the Intelligent Learning Model (Wang, 2011), and the
testing involved a focus group of 5 users. During my second visit, the system was tested with a larger number of targeted users. The large-scale testing was guided by an updated the Intelligent Learning model (Figure 1) and a newly developed evaluation matrix (Table 1), revised based on the previous small-scale testing. In addition, a structural model of Mobile Class system was presented (Figure 2). This document reports on these products of my work.

1. Introduction and Theoretical Background

In my previous report to EBTIC, *The Architecture of a Cloud-based Intelligent Learning System (C-iLearning)* (Wang, 2012) and a published conference paper (Wang & Ng, 2012), we described the structure of this C-iLearning system, and introduced an exemplary prototype--the "Mobile Class", which was built on the Intelligent Learning Model (Figure 1): *Learning, Assessment, Communication, and Analysis (LACA)*. The conclusions of my last report stated that this system will be further developed and that more testing would be conducted on a larger scale (in terms of learners and learning content). These tasks have now been completed and this report details my work.

This Mobile Class system supports mobile learning by providing materials that can be accessed by a variety of learning devices, including mobile phones. The system is built upon the intelligent cloud learning concept and the model used (*Figure 1. Recursive intelligent learning model*) was described in a previous report submitted to EBTIC--*An Intelligent learning model based on cloud computing* (Wang, 2011).
Figure 1. The “Recursive” intelligent learning Model (revised in July 2012)

This model has been fine-tuned based on the last round of testing, mainly in the words used to describe the functions in each domain (Learning, Assessment, Analysis, and Communication). Formatting inconsistencies have also been corrected.

This Cloud-based intelligent learning system (C-iLearning system) is also built upon the Mobile Cloud Education concept, a novel cutting-edge research in the area of intelligent learning (Wang & Ng, 2012). Mobile cloud education refers to a natural unification of cloud and mobile learning, attributing to the overlaps between the characteristics of these two learning modalities (Wang & Ng, 2012). The Mobile Class system uses cloud service to support learner autonomy when learning with different devices (e.g., phone, iPad, laptop, and desktop) in the interactive online environment. Figure 2 is a visual display of the Mobile Class system architecture, which has been further developed in the first six months of 2012.

In mobile cloud learning (MCL), learners can communicate with teachers and other learners about their study, questions or problems. When teachers answer these questions, the intelligent learning system can automatically match the questions with corresponding answers and then save them in a database. Next time, when the same questions are asked, the system will match the questions with answers and present the answers to the users. The intelligent learning system can also
extract typical questions or problems through Extract, Transform, and Load (ETL), collect learners’ study notes, and then save all these important resources in the database. ETL is a process in database usage and especially in data warehousing that involves: (1) extracting data from outside sources, (2) transforming it to fit operational needs (which can include quality levels), and (3) loading it into the end target (database or data warehouse). The database will process and analyze these collective resources and provide value-added feedback to learners. Through all these functions, learning is a less isolated activity. Learners can interact more frequently with others, which will greatly improve their interests and expand their knowledge.

The Mobile Class system adopts cloud management to synchronize learning records to the “cloud” anytime and anywhere, where learners can continuously learn with different devices. This system is built for learners who are used to informal learning. Overall, the mobile portal cloud
mainly supports learners’ registration, login, individual data, learning portfolio, and learning records.

As shown in Figure 2, its mobile portal cloud consists of four management centers: personal information management, learning management, course management, and display and visit management center. Each center has several functional modules, shown in Figure 2.

A. **The personal information management center** has two functional modules: information management and community interaction. The information management module includes user registration and log-in as well as personal information management. And the community interaction module includes BBS, sharing, and uploading contents.

B. **The learning management center** has four functional modules: adaptive learning, knowledge evaluation (assessment), course learning, and continuous learning. Adaptive learning refers to the learning perception management and the learning model management. The assessment module includes test choice, problem sets, scores, and the add-up of the learning results. The course learning module includes curriculum syllabus, course display, work schedule, and homework. The continuous learning module contains course bookmarks and course preload management. Together these modules can support learners’ entire learning process, their communication and activities from the beginning to the end.

C. **The Course management center** provides learners with resources and support services, and it has three modules: course retrieval, course classification, and intelligent recommendation. Course retrieval module includes course inquiry and keyword search, course ranking, and reading collection. Course classification module can classify from more than one dimension such as category, stage, source, crowd, evaluation, content provider and keywords. In addition, it can also display courses. Intelligent recommendation module will push a list of recommendations to users according to their preferences, places visited in the learning system, and their learning records. It can also send direct messages to the users.

D. **The display and visit management center** contains terminal identification, layout management, push subscription, and right management, which can automatically identify user’s devices and adaptively recommend learning content. Terminal identification module refers to the intelligent adaptive content output function based on the identification of the
different mobile browsers and screen resolutions. In layout management, the administrator manages and maintains the content of the page. In the subscription-and-push module, users can subscribe to all kinds of learning information, and the administrator can push real-time information and recommend courses or learning materials to the user. Finally, the authority management module includes user management, role management (students, teachers or administrators), and assign different roles to users: visitors (not registered users), ordinary users (register online), real name users, and course users.

Technically, this system is an intelligent and user-friendly learning platform. It harnesses the power of the Internet to reduce development cost and operational expenditure (OPEX). It also provides web cloud application based on HTML5 standard for all kinds of mobile platform to achieve cross-platform and cross-terminal compatibility. To handle external desktop browsers, the visit management can provide intelligent client applications for the mainstream platforms and operating systems, such as Android and IOS.

This “Mobile Class” system promotes an intelligent learning environment, featuring a "recursive cycle", so as to provide learners with personal and intelligent services. It uses cloud services and provides a personalization system to allow the users (students & teachers) to customize the learning system according to their needs. Security issues were also taken into consideration in the system. For instance, data should be encrypted for transmission. The developed system was tested with target users for usability and instructional effectiveness and this report details the process and results.

2. Details about the Testing Conducted on “Mobile Class”

2.1 Environment and equipment

Our last small-scale testing was conducted using Android mobile phones and the IOS iPad. Considering the interface and operating system differences of Android and Apple, the continued development of the Mobile Class system targeted Apple platforms first. Therefore, the current large-scale testing was conducted on Apple’s iPhone 4. Android testing will be conducted in the near future.
2.2 Description of the Evaluation Method and Matrix (Table 1)

There are mainly four ways to test educational systems and platforms: expert analysis, observation of users, key performance indicators (KPIs), and experimental assessment. I chose the most objective method (KPIs) to evaluate Mobile Class. Real users (learners) rated the system from the following aspects: Instructional design (with consideration for mobile cloud learning), Interface design, Interaction design (supported by cloud), and the Technical functionality.

The evaluation matrix I developed (see Table 1) synthesizes the evaluation indexes from the E-learning courseware certification (ECC) standards of American society for training & development (ASTD, 2002) and CELTS-22 (Ministry of Education, 2003; Zhu, 2001), a set of specifications for evaluating web-based courses published by the informatization standards committee of China’s Ministry of Education. This matrix has four major categories: Instructional Design, Interface Design, Interaction Design, and Technology/technicality. Each of the four categories has several sub-categories, which included features related to mobile and cloud learning.

The structure of the evaluation index system is shown in Figure 3. When developing the index, I also took into consideration the characteristics of mobile cloud learning and the learners. The
following provides details about the four categories:

1) Instructional design improves the learning efficiency by improving the content design of the courseware, in the clarity of teaching and learning objectives, the learning process, learning strategy, and evaluation.

2) Interface design brings pleasant visual experiences to users by unified, coordinating and beautiful interface style.

3) Interactive design means that the courseware has good interaction with easy operation, which can not only support human-computer interaction but also provide online platform for human - human interaction.

4) Technology environment or technicality: The using hardware and software technology can support the reliable installation, operation and uninstallation for mobile courseware and easy to share.

The usability of this mobile class system is reflected by navigation design, ease of use design, and interaction design.

1) Navigation design needs to conform to the following principles: a) overall navigation is convenient for users to quickly search and change functional modules; b) the navigation area should have enough spaces to present course content; and c) the frequently used menu items are easy to find.

2) Ease of use design includes three aspects: button design, adaptability to screen sizes, and video and audio quality. Standard button size is 1.75*0.65 cm when users visit system through mobile phone, and it should be larger than normal adult’s thumb coverage width. Second, a mobile cloud learning system with good adaptability should be able to the terminal screen size, either smart phones or iPad. Third, in different network environment, a learning system should be able to adjust video and audio quality to the learning devices used.

3) Interaction design focuses on learner interactions around the course content. The Mobile Class system needs to be able to support learner’s communication and collaboration.

Table 1. System Evaluation Matrix
(Rating scale of 5-1: strongly Agree, agree, neutral, disagree, strongly disagree)
<table>
<thead>
<tr>
<th>Evaluation Categories</th>
<th>Evaluation Sub-categories</th>
<th>Obligatory nature</th>
<th>Index Description (best-case)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructional design</strong></td>
<td>Navigation</td>
<td>M (Must)</td>
<td>The system is clearly designed. You can easily identify your locations throughout the course and easily access each module.</td>
</tr>
</tbody>
</table>
|                        | Search (function & result) | M                | 1) The learning system supports a variety of searches.  
2) The system returns the search results fast. |
|                        | Learning support         | M                | You can get adaptive learning assistance and guidance on FAQs, courseware usage, tips for learning, and the important and challenging content. |
|                        | Learner control          | O (Optional)     | The system supports anytime anywhere learning. Your study is more self-paced, and you can select what to study. |
|                        | Assessment               | M                | 1) The system can provide the appropriate number of assessment questions.  
2) The test is reliable and is at the right level for the learner. |
<p>|                        | System feedback and guidance to learning | M | Provides timely and effective feedback after testing, exercise and learning, similar to the feedback system in level-based games. Learners will be motivated to continue their study. |
|                        | Benefits of mobile cloud learning (MCL) | O (Optional) | mLearning can solve the schedule conflict between work and study. |
|                        | Learning outcomes        | O                | Comparing to traditional learning, mLearning can effectively improve learning efficiency and learning outcomes. |
| <strong>Interface design</strong>   | Operationability         | M                | The system is easy to use and conforms to the psychology of learning. You can easily use it without much help. |
|                        | Screen adaptability      | M                | The system can adaptively display content on different learning devices. |
|                        | Use of color             | M                | Colors are reasonably matched and are appealing and comfortable to your eyes. |</p>
<table>
<thead>
<tr>
<th><strong>Interactions</strong></th>
<th><strong>(definition)</strong></th>
<th><strong>(with “cloud” features)</strong></th>
<th><strong>(technology environment)</strong></th>
<th><strong>Overall Evaluation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface clarity</td>
<td>M</td>
<td>The interface is clearly structured and easy to navigate.</td>
<td>System stability</td>
<td>M</td>
</tr>
<tr>
<td>Interaction design</td>
<td>O</td>
<td>When you switch learning devices (e.g., from laptop to cell phone), the system can resume from where you stopped.</td>
<td>Speed of server response</td>
<td>M</td>
</tr>
<tr>
<td>Level of intelligence</td>
<td>O</td>
<td>The system can remember your learning habits and recommend learning resources accordingly.</td>
<td>Functional Independence</td>
<td>O</td>
</tr>
<tr>
<td>Interaction between learners and the mobile terminals/devices</td>
<td>M</td>
<td>Learning devices with non-touchable screen: uses key shortcuts (left soft as enter, right soft as exit), use page number keys to turn the pages. With touchable screen: support multi-touch, and drag-drop. Supports various interactive modes such as jigsaw, touch flop, and interactions (Q-A, feedback, modeling, simulations, etc.)</td>
<td>Level of Satisfaction</td>
<td>M</td>
</tr>
</tbody>
</table>

**Note:** Obligatory nature means whether the evaluation criterion is a Must-have or an Optional one.

### 2.3 Testing Process and Screenshots

There were a total of forty evaluators (learners), using either iPhones or iPad, to access one course -“the fantastic fountain”. Each learner studied it for about 15 minutes, using the following procedure:

- Log in from: [http://m.shlll.net](http://m.shlll.net): username: drcltest001 password: 123456
- Click “Linguistic Literacy”, which is at the end of the Course List
• Click “The fantastic fountain”—First one on the list

• Enter the course main page, play the video and access other course material.

• Click on the course Menu, and go through each chapter, take the quizzes, provide course comments, and answer a few survey questions.

• Once the study is completed, click “completed”, then store this course in one’s Individual Center.

During each step, system testers (learners) scored the system on the scale of 5 (strongly agree) to 1 (strongly disagree) as shown in Table 1 (The Evaluation Matrix).

The following screenshots (Figures 4-8) illustrate the log-in and learning process:

![Course Interface (with user rating & the number of times course has been used)](image)

Figure 4. Course Interface (with user rating & the number of times course has been used)
Figures 5-6. Log-in and Study the content
3. Results and Analysis

Background: Summary of the Prototype Evaluation: from conference paper published (Wang & Ng, 2012)

Overall, the total score for the mobile cloud education system was about 92 out of 135 based on all the listed evaluation criteria. In other words, its percentage rating is about 68.2%. This is
composed of a subset of about 68 out of 100 for the “Must” criteria (i.e., 68.0%) and a subset of about 24 out of 35 for the “Optional” criteria (i.e., 68.6%). A summary of the system evaluation score is pictorially illustrated below. As seen from the figure, the system’s “Instructional Design” (especially its “Learning support” category) has room for further enhancement and improvement, as compared to the other three design issues.

Figure 9-10. Mobil Class Prototype evaluation results (Wang & Ng, 2012)

3.1 Results

Demographics of users

A total of 40 users participated in the system testing, with 80% being male and 20% being female. The age ranges are distributed as, 20-30 (70%), 30-40 (30%). Following are the tabulations of scores for the four categories.
### Table 2. Scores for Instructional Design (On the scale of 0 to 5, decimals are rounded to the nearest point)

<table>
<thead>
<tr>
<th>Category</th>
<th>Obligatory nature</th>
<th>Sub-category</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation</td>
<td>M</td>
<td>Search function</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Search result</td>
<td>4.2</td>
</tr>
<tr>
<td>Search</td>
<td>M</td>
<td>Control of personalized learning</td>
<td>4.4</td>
</tr>
<tr>
<td>Learning support</td>
<td>M</td>
<td>Quality of test items</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Assessment feedback</td>
<td>4.4</td>
</tr>
<tr>
<td>System feedback and guidance to learning</td>
<td>M</td>
<td></td>
<td>4.25</td>
</tr>
<tr>
<td>Benefits of mobile cloud learning (MCL)</td>
<td>O</td>
<td></td>
<td>4.3</td>
</tr>
<tr>
<td>Learning outcomes</td>
<td>O</td>
<td></td>
<td>4.45</td>
</tr>
<tr>
<td>Total score</td>
<td></td>
<td></td>
<td>42.95 (out of 50)</td>
</tr>
</tbody>
</table>

### Table 3. Scores for Interface Design

<table>
<thead>
<tr>
<th>Category</th>
<th>Obligatory nature</th>
<th>Sub-category</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operationability</td>
<td>M</td>
<td></td>
<td>4.3</td>
</tr>
<tr>
<td>Screen adaptability</td>
<td>M</td>
<td></td>
<td>3.95</td>
</tr>
<tr>
<td>Color use</td>
<td>M</td>
<td></td>
<td>4.05</td>
</tr>
<tr>
<td>Interface clarity (definition)</td>
<td>M</td>
<td></td>
<td>4.05</td>
</tr>
<tr>
<td>Total Score</td>
<td></td>
<td></td>
<td>16.35 (out of 20)</td>
</tr>
</tbody>
</table>

### Table 4. Scores for Interaction Design

<table>
<thead>
<tr>
<th>Category</th>
<th>Obligatory nature</th>
<th>Sub-category</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-screen in One</td>
<td>O</td>
<td></td>
<td>4.5</td>
</tr>
</tbody>
</table>
### Table 5. Technical Design

<table>
<thead>
<tr>
<th>Category</th>
<th>Obligatory nature</th>
<th>Sub-category</th>
<th>Average score</th>
</tr>
</thead>
<tbody>
<tr>
<td>System stability</td>
<td>M</td>
<td></td>
<td>4.05</td>
</tr>
<tr>
<td>Speed of server response</td>
<td>M</td>
<td></td>
<td>4.2</td>
</tr>
<tr>
<td>Functional independence</td>
<td>O</td>
<td></td>
<td>4.25</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>12.5 (out of 15)</td>
</tr>
</tbody>
</table>

#### 3.2 Analysis of the Testing Data for the Further Developed Mobile Class System

In summary, the total score for Mobile Class system is 92.85 out of 100 and its percentage rating is 92.85%, which indicates the overall improvement in all aspects of the system (instructional design, interface design, interaction design, and technical design). The criteria marked with M (Must) are scored at 66.9 out of 70 (i.e., 95%), and the criteria marked with O (Optional) are scored at 25.95 out of 30 (i.e., 86.5%). Following are detailed descriptions of testing results on the four aspects of the Matrix: instructional design, interface design, interaction design, and technical design.

#### 3.2.1 Instructional Design

Overall, instructional design of the system is satisfactory and the ratings improved a greatly.
As shown in both Table 2 and Figure 11, all items received high ratings (4.2 to 4.45). Learning outcomes from using Mobile Class had the highest rating (4.45 of 5), followed by learner control (4.4), assessment feedback (4.4), and benefits of mobile cloud learning (4.3). Search efficiency and learning support received slightly lower ratings (4.2). These scores indicate that mobile cloud learning can strengthen learning efficiency. The system is able to support anytime anywhere learning; learners enjoyed their control of what to learn and other flexibilities of learning.

### 3.2.2 Interface Design

Figure 12. Bar graph of user ratings for interface design
As shown in Table 3 and Figure 12, the system interface received reasonable scores (from 3.95 to 4.3). Operationability, which refers to the ease of use of the system, had the highest rating (4.3). Color use and interface clarity (definition) had an equal rating of 4.05. Screen adaptability had the lowest rating and needs improvement.

Similar to our earlier testing on the prototype, 80% of the users thought the interface design was consistent, with excellent use of color and contrast (white and green). Language use aligns with Chinese and English standards. Pictures were appropriately inserted to illuminate the content. From an eligibility perspective, fonts used in the courseware were found to be of the right size. In addition, video resolution was reported as being high, with clear narration and engaging soundtrack. From the usability perspective, the interface was found easy to navigate. Its design conformed to educational psychology guidelines, and evaluators were able to use all the features of the course without human or automatic assistance.

### 3.2.3 Interaction Design

![Bar graph of user ratings for interaction design](image)

**Figure 13.** Bar graph of user ratings for interaction design

As shown in Table 4 and Figure 13, “multi-screen in one” received the highest rating (4.5) for the Mobile Class. The “multi-screen in one” function epitomizes the cloud-learning feature of this learning system. When learners switch learning devices (e.g., from laptop to cell phone), the system can resume from where they paused before switching. The system’s support for learner interaction
also got a reasonable score of 4.2.

Also, similar to the testing conducted during my last visit, users liked all the interaction features, including taking the test and getting immediate feedback, selecting what to study, the system records of their learning path and progress, and the technical and study reminders. In addition, they reported liking the touch-screen function more than keyboarding. Touch-screen makes the interaction more direct and effective, which seems to increase the learners’ sense of interaction with the system.

3.2.4 Technology/Technical Design

![Bar graph of user ratings for technical design](image)

Technical design includes three aspects: system stability, response speed of the server, and functional independence of the learning terminal (device). Functional independence refers to the separation of mobile courseware from other functions on the mobile device (e.g., making phone calls on the phone). As table 5 and Figure 14 reveal, functional independence of the learning devices got the highest rating (4.25). The server responded to user requests at reasonable speed, normally within a few seconds. In comparison, system stability (rated at 4.05) needs improvement.

4. Conclusions and Suggestions for Future Work

A further-developed mobile cloud learning system, “Mobile Class”, was tested with 40 users, who accessed the learning material using iPhone 4. Regular functions on all devices (making calls, taking notes etc.) were not interrupted during the testing.

Overall, 35% of the users rated their experience with “Mobile Class” as very satisfactory, and 50% rated it as satisfactory. This high percentage (85) proves the success in designing and
developing this innovative learning platform.

Plans for future work: 1) This system will be further developed and tested with Android platforms. More data will be collected to show the effectiveness of this system in supporting mobile cloud teaching and learning. 2) The system will have an English interface and can be accessed by learners from communities worldwide. And 3) Collaborate with ANKABUT to implement and test this system with users from UAE.

References


