Design of a Microlecture Mobile Learning System Based on Smartphone and Web Platforms

Chuanxue Wen and Junfei Zhang

***Abstract*—This paper first analyzes the concept and features of microlecture, mobile learning, and ubiquitous learning, then presents the combination of microlecture and mobile learning, to propose a novel way of micro-learning through mobile terminals. Details are presented of a microlecture mobile learning system (MMLS) that can support multiplatforms, including PC terminals and smartphones. The system combines intelligent push, speech recognition, video annotation, Lucene full-text search, clustering analysis, Android development, and other technologies. The platform allows learners to access microlecture videos and other high-quality microlecture resources wherever and whenever they like, in whatever time intervals they have available. Teachers can obtain statistical analysis results of the microlecture in MMLS to provide teaching/learning feedback and an effective communication platform. MMLS promotes the development of microlecture and mobile learning. A statistical analysis of the implementation of the system shows that students using MMLS to assist their learning had improved results on their final exams and gave a higher evaluation of the curriculum than those who did not. The advantages and disadvantages of MMLS are also analyzed.**

***Index Terms*—Android, microlecture, mobile learning, smartphone.**

TODAY'S "hot" concept of microlecture was proposed in 2008 by David Penrose, the senior teaching designer and advanced teaching college online service manager of San Juan College, Farmington, NM, USA. Penrose considered the core of microlecture to be micro-video, including related contents such as micro lesson plans, micro courseware, micro exercises and micro reflection [1]. Generally, a micro-video lasts from 5 to 8 min and does not exceed 10 min.

Mobile learning (M-Learning) is a new learning mode based on mobile terminal computing and wireless network transmission ability. Students can study on a variety of mobile terminals (such as smartphones or tablets) via mobile communication networks or wireless local area networks (LANs) [2]. M-learning has gradually introduced a ubiquitous learning system and constitutes a new research field [3]. Learners can get the information they need, at any time, anywhere, using fragments of time in their busy schedules and achieving a real sense of autonomous learning. The core idea presented here is to merge microlecture and M-learning.

Nowadays, the data processing ability of smartphones rivals that of computers. Rapid development of mobile communication technology has resulted in most campus areas being covered by WiFi. These factors support an M-learning platform. The combination of microlecture and M-learning yields the best of both, as learners can, at any time or place, conveniently study fragmented knowledge through their mobile terminals. Brief, targeted microlectures only require mobile learning platforms to be effective.

Microlecture is getting more and more attention, but the discussion is limited to its production and teaching methods [4]–[6] and its use in remote online teaching [7], [8]. Little of the literature describes either how microlecture applies in mobile learning, or the design and construction of microlectures or mobile learning platforms.

I. Combination of Microlecture, Mobile Learning, and Smartphone Terminal

A. Microlecture, M-Learning, and Ubiquitous Learning

Microlecture can serve personalized learning and on-demand selective learning, helping learners to acquire new knowledge and remedy omissions in their existing knowledge. Surveys have found that students' concentration can last up to 10 min in a networked classroom. Online courses, however, are usually about 45 min long, making it difficult to maintain concentration throughout. Microlecture is expected to revolutionize teaching and research, replacing the traditional teaching/evaluation model. For this to happen, a suitable platform for microlecture will be one convenient for students to use in their spare time, and one that allows communication between teachers and students. M-learning, based on digital learning and mobile computing technology, is regarded as the future learning mode [9], [10]; students can not only use mobile terminals to collect a large amount of learning resources, but also can set their personalized learning schedule to suit their circumstances. Ubiquitous learning (U-Learning), as its name implies, refers to communication and learning at any time or place.

B. Microlecture Application on Mobile Phone Terminals

Being targeted and efficient, microlecture is a perfect combination of mobile learning and the fragmented time availability

Manuscript received September 08, 2014; accepted October 05, 2014. Date of publication November 06, 2014; date of current version July 31, 2015. This work was supported by the Guangzhou Education Science Twelfth Five Year Plan 2013 Annual Program under Grant 2013A142, the Guangzhou Medical University Science and Research Project under Grant 2012A01, and the Guangdong College Basic Computer course Research and Practice Program 2014 under Grant B01. *(Chuanxue Wen and Junfei Zhang contributed equally to this work. Corresponding author: Chuanxue Wen.)*

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Digital Object Identifier 10.1109/TE.2014.2363627

characteristic of today's learners. When microlecture encounters M-learning, ubiquitous learning becomes more effective and viable.

Most current research into microlecture focuses on the concept and the implementation of its technology. This is inadequate. Microlectures currently exist in the form of network curricula. However, increasingly mature mobile hardware technology and mobile communication technology have accelerated the development of smartphones. Advanced technology and the need for lifelong education prompt the development of M-learning. Various authors have reported research and development of mobile learning course platforms [11]–[14], but the combination of microlecture with mobile terminal applications is rare.

The new model of using mobile terminals to learn can take advantage of short time increments. For this fragmented learning, M-learning using phone terminals has advantages over the traditional network curriculum. This paper proposes the development of microlecture from an online computer-based course to micro resources on a mobile terminal. The design is described of a multifunctional mobile learning platform for microlecture that combines high-quality digital microlecture resources and mobile learning. This combination, a new education model, will greatly promote the popularity of microlecture.

II. Design of the Microlecture Mobile Teaching Platform

The microlecture M-learning system (MMLS), shown in Fig. 1, consists of three parts: the student terminal, the teacher terminal, and the central server. Teachers and students can use smartphones or Web platforms to log in, which retains the traditional learning platform but also adds the new M-learning platform. In addition to general functions like video upload and playback, further designed-in features on the central servers include video annotation technology, video and correlate label text display, Lucene full-text search technology, and microlecture comprehensive evaluation analysis. MMLS offers multiterminal, multiplatform, and multifunction support to better integrate microlecture and M-learning.

The MMLS operation sequence is shown in Fig. 2. Teachers can upload microlecture resources to the streaming media server via a Web server. Students can access microlecture resources from a mobile terminal or Web platform and make video annotations and evaluations and ask questions while learning. Teachers receive SMS alerts when students ask questions and can reply through the interactive platform, which allows communication between teachers and students and offers valuable advice in the classroom. The terminal platform uses a cluster analysis algorithm to calculate the appropriate quality of video resources, then intelligently pushes the results to the learner's interface.

The central Web server uses Lucene technology to index microlecture resources to improve the learners' recall ratio and precision of searching. A statistical analysis is made of the number of visits and the evaluation of video resources. The statistics are pushed to students and fed back to the teachers and administrator, providing valuable reference for learning and teaching.

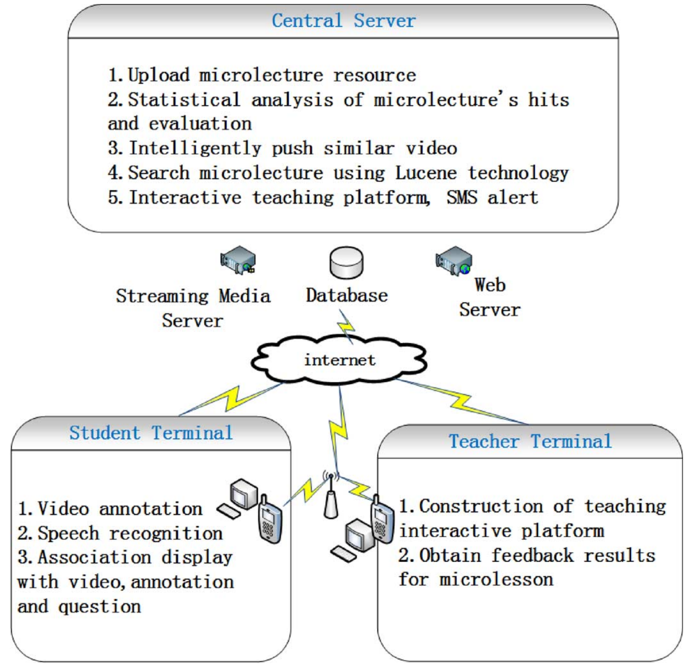

Fig. 1. MMLS system overall structure and functionality.

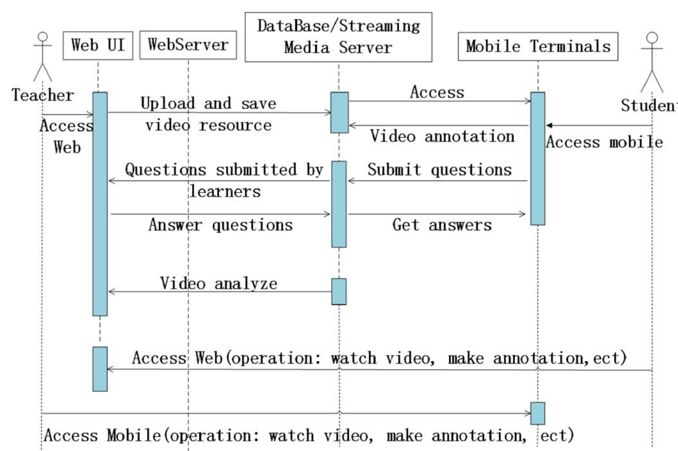

Fig. 2. MMLS operation sequence.

III. Platform Features

A. Video Annotation and Speech Recognition Applications

While watching a micro-video clip, learners can make notes by clicking a button and entering labeling information in the text box. The video location and labeling information are submitted to the local database, and then uploaded to a remote server [15]. When learners revisit the label position on the video, the annotation information is triggered. The client player platform uses AJAX technology to show the annotation on the video in real time, making an organic association between the annotation and the video. To retrieve the content of the video, learners can search for the annotation, then click on it; this is associated with the corresponding time on the video clip, consequently allowing video retrieval, as per the video annotation flowchart in Fig. 3.

Video annotation technology has been a topic of much interest in the area of education. Although this has been achieved

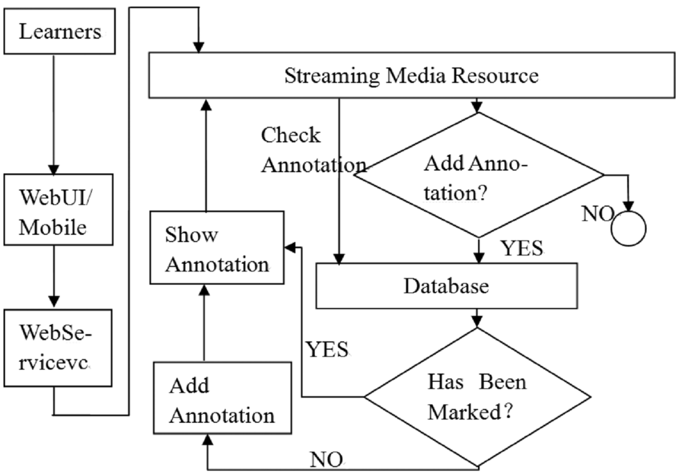

Fig. 3. Video annotation flowchart.

on YouTube [16], the technology has not been promoted in education.

In addition to annotating the video, students can send the teacher questions on the microlecture video; these are sent as an SMS alert that teachers can see and reply to when they log in. Unlike other teaching platforms, MMLS associates videos, questions, and answers in an extended application of video annotation. If students click on a question, the corresponding video clip will be played, so that learners can benefit from the teachers' reply. In addition to text annotation on the mobile terminal, speech recognition technology has also been adopted for video annotation; this more user-friendly mobile terminal application makes it convenient for students to annotate on the go.

The client video player, which adopts FlashAir technology to integrate multiple desktop-like applications, is a cross-platform system offering a good user experience. The player designed into MMLS features video annotation and association between the video and the annotation.

B. Lucene Full-Text Search Engine

MMLS uses a full-text search engine based on Lucene technology. Full-text search can solve the failed lookup situation when the query word does not exactly match the database. Moreover, full-text search offers higher performance than the simple query search [17]. The schematic diagram of full-text search principle is shown in Fig. 4. First, the platform uses Lucene to establish a database index for the video resources, then segments the search key text into words. It then uses Lucene to read this index and do a fuzzy search or an advanced search for the index keywords. Using Lucene technology enhances the recall ratio and the precision and speed of the search.

C. Microlecture Resource Analysis and Intelligent Push

The Web server uses a data mining technique to make a comprehensive statistical analysis of microlecture resources and delivers the results to the learners and teachers. Learners can use these to locate high-quality teaching resources. Teachers can use the results to assess the learners' progress, and then adjust their teaching plan. This acts as a good communication and feedback platform.

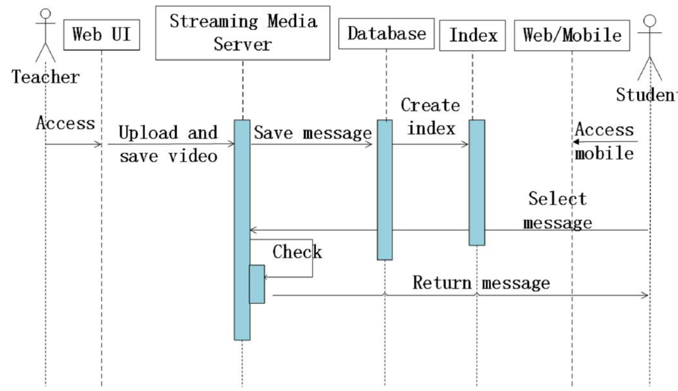

Fig. 4. Full-text search schematics diagram.

TABLE I
SPECIFIC SURVEY RESULTS

	Control group	Experimental group
Difficult level	9.42	7.31
Theory and practice comprehension	8.04	9.22
Interest in the courses	7.55	8.53

The server analyzes a user's requirements and determines high-similarity microlecture resources using a clustering analysis algorithm. It then intelligently pushes high-quality microlecture resources to the learners' interface using XMPP protocol, which helps learners explore the microlecture efficiently. Intelligent push technology and data analysis technology not only enable learners' active learning, but also make resource acquisition intelligent [18].

IV. IMPLEMENTATION AND EVALUATION

At present, MMLS holds the digital resources of 12 courses, among them Data Mining, Digital Signal Processing, MATLAB and Visual Basic Programming. The courseware and video curriculum recording were made either by the teachers of Guangzhou Medical University, Guangzhou, China, or by internationally renowned professors. MMLS is open to teachers and students of the institution, and its server is located in its Information Center Department.

To test MMLS's effectiveness, the authors selected three courses and four intakes of students for study. The 2011 and 2010 intakes, each of 60 students, were designated as the experimental group. Learning in the classroom as well as by MMLS, each experimental group student was required to take more than 15 microlessons for each course. The control group consisted of the 2009 and 2008 intakes, also 60 students each. With MMLS not being in use at that time, they learned only in the traditional classroom.

At the end of the semester, both groups were asked to rate the courses and MMLS (for the experimental group) separately. The scores, shown in Table I, were on a scale of 1 to 10, where the greatest difficulty, interest, and intelligibility were to be graded with a 10. It can be seen that after the introduction of MMLS, the course difficulty decreased, and interest and intelligibility increased.

TABLE II
FINAL SCORE AVERAGED ACROSS THREE COURSES

	<60	60-70	70-80	80-90	>90
Data Mining					
2008 Intake	10.00%	30.00%	30.00%	21.67%	8.33%
2009 Intake	8.33%	31.67%	28.33%	23.33%	8.33%
2010 Intake	5.00%	15.00%	31.67%	35.00%	13.33%
2011 Intake	6.67%	13.33%	30.00%	33.33%	16.67%
Digital Signal Processing					
	<60	60-70	70-80	80-90	>90
2008 Intake	11.67%	33.33%	30.33%	18.33%	6.67%
2009 Intake	10.00%	31.67%	28.33%	21.67%	8.33%
2010 Intake	5.00%	13.33%	31.67%	35.00%	15.00%
2011 Intake	5.00%	13.33%	30.00%	35.00%	16.67%
Matlab					
	<60	60-70	70-80	80-90	>90
2008 Intake	6.67%	18.33%	28.33%	33.33%	13.33%
2009 Intake	5.00%	20.00%	30.00%	33.67%	11.67%
2010 Intake	5.00%	13.33%	25.00%	40.00%	16.67%
2011 Intake	5.00%	11.67%	23.330%	41.00%	18.33%

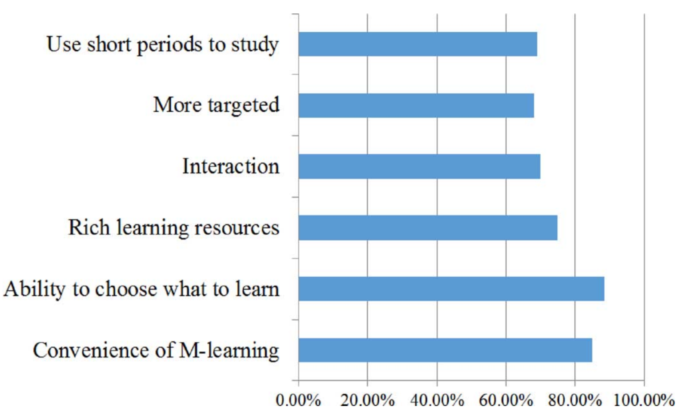

Fig. 5. Student rating of the various motivating factors for the platform.

A Z-test was used to analyze the students' final exam scores, shown in Table II. Students are graded out of 100, with a score below 60 being a "fail," and above 90 an "excellent." The intersection point between the experimental group (2010 and 2011 intakes) and control group (2008 and 2009 intakes) results is at the score of 70 to 80; that is, the number of higher grades increases, and the number of students scoring less than 70 decreases. There were very significant differences after introducing MMLS in the Data Mining and Digital Signal Processing courses ($P = 0.0027$ and 0.0015 respectively), and a significant difference in the MATLAB course ($P = 0.03114$). As is well known, digital signal processing and data mining courses are more difficult than MATLAB courses. The effect of MMLS is more prominent on difficult courses with a lower P value. Also, the final exam results show that the experimental group achieved a higher average mark than the control group.

Also captured were the factors students found most motivating or demotivating while using MMLS. These are combined and listed for the two modules in Figs. 5 and 6, respectively. Students could select multiple options. Most appreciated the "ability to choose what to learn" and the "convenience of M-learning." "Rich learning resources" were another strong

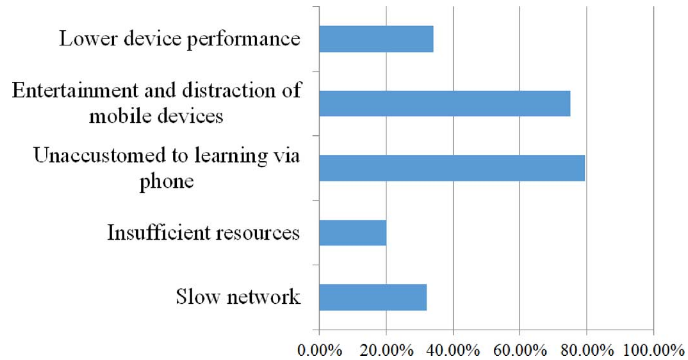

Fig. 6. Student rating of the various demotivating factors for the platform.

motivating factor when working on these projects. "Unaccustomed to learning via a phone" and "entertainment and distraction of mobile devices" were the two biggest demotivating factors.

V. CONCLUSION

Having discussed the concept and significance of microlecture and M-learning, this paper has proposed the new idea of combining microlecture and M-learning and detailed the design of the MMLS that supports multiplatform learning.

The authors' analysis of the results for two groups of students showed that MMLS improved students' final exam results and enhanced their understanding of and interest in the curriculum. Students considered the biggest problem in this new learning model to be the strong entertainment potential of mobile devices, resulting in them easily being distracted when learning. A considerable number of students did not become accustomed to M-learning, which underlines the need for a period of adaptation and improvement when introducing a new learning methodology. Overall, MMLS' innovations are the following.

1) It combines microlecture and M-learning for a ubiquitous learning mode and provides two learning access platforms for PC terminals and smartphones, so that learners can benefit from specific microlearning whenever they have a spare minute.
2) It correlates annotation text with microlecture video and displays them together, which makes it convenient for users to retrieve video resources. Speech recognition is also adopted for video annotation on the Android mobile terminal.
3) It uses data mining techniques such as cluster to analyze popularity, visits, and similarity of the microlecture, then intelligently pushes the result to learners, making the platform initiative and intelligent.
4) It adopts a full-text Lucene-based search engine on Web and mobile platforms to retrieve microlecture resources. By establishing a database index, and segmenting keywords, a convenient, fast, comprehensive search for related learning resources can be achieved.

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