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The impact of mobile learning on students' learning behaviours and performance: Report from a large blended classroom

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Abstract

Chinese classrooms, whether on school grounds or online, have long suffered from a lack of interactivity. Many online classes simply provide recorded instructor lectures, which only reinforces the negative effects of passive nonparticipatory learning. At Shanghai Jiaotong University, researchers and developers actively seek technologic interventions that can greatly increase

interactivity in large blended classes. They developed a cutting-edge mobile learning system that can deliver live broadcasts of real-time classroom teaching to students with mobile devices. Their system allows students to customise means of content-reception based on when and where they tune into the broadcast. The system also supports short text messaging and instant polls. Through these venues, students can ask questions and make suggestions in real time, and the instructor can address them immediately. This article describes this system in detail, and also reports results from a formal implementation of the system in a blended English classroom of 1000 students (with about 800 being online). As the data reveal, m-learning activities can much better engage students in the learning process. Students in this class changed from passive learners to truly engaged learners who are behaviourally, intellectually and emotionally involved in their learning tasks.

Introduction

In the last decade, distance education has developed in two major directions: 'the individual flexible teaching model' and 'the extended classroom model' (Rekkedal & Dye, 2007). The former allows students to start the class at any time, study in isolation and communicate with instructors and classmates through asynchronous tools. The latter organises students into groups, requires them to meet at local study centres, and allows them to use interactive technologies such as video conferencing to interact (Rekkedal & Dye, 2007). The global penetration rates of mobile devices now allow teaching institutions to experiment with bringing these new modes of teaching to even more remote audiences. Worldwide, nearly 2.7 billion active mobile phones exist (Ahonen & Moore, 2007), sometimes as the sole means of long-distance communication. Mobile learning in China and other industrialising nations will grant entire populations access to these new opportunities in the near future. Through adapting the current curriculum for interactive teaching and learning, researchers and developers in the E-Learning Lab and Network Education College of Shanghai Jiaotong University hope to set an example for future pedagogical changes and greater access to China's higher education system. This College's motto and mandate is providing 'Learning Anytime, Anywhere', which is accomplished through extending the real classrooms and also supporting individualised learning. New advances in learning via cellular and mobile technologies will help bring this goal within closer reach.

Context

The online College (ie, Network Education College) detailed in this paper employs both synchronous and asynchronous distance learning models and allows students to choose according to their needs and preferences. An array of software and hardware digitises all lectures and activities that go on in a campus classroom and broadcast them to online students. Because a great number of the College's students work full time, the institution attempts to provide flexible access to course content. Students may currently

come to campus, go to the many learning centres around China, tune into live broadcast with mobile devices, or watch an archived video of a class online. Learners appear to enjoy this flexible, student-centred approach. In 7 years (2002–2007), this college's enrolment has grown from 200 students to 17 000 students.

However, instructors and instructional designers within the college noted a deficiency in their course design: the live broadcast system does not provide interactive venues. Distance students can watch and listen to the live classrooms, but cannot ask questions or participate in any activities. The m-learning system invented by the E-Learning Lab (a research and development laboratory within the College) aims to provide venues for interactive and active learning.

Active learning techniques can greatly benefit students. Research (eg, Bailey, 2004; Ratto, Shapiro, Truong & Griswold, 2003) has demonstrated that active and interactive learning techniques help learners acquire knowledge, develop critical thinking skills, solve problems in a variety of situations and think independently. By contrast, passive learning is based on the view of teaching as knowledge transfer, which treats learners as 'receivers' of knowledge in verbal forms from books and instructors (Bailey, 2004). Passive learning also creates problems from an instructor's perspective (an important viewpoint in any ecological examination of a learning environment) (Ratto *et al*, 2003). Noninteractivity obligates instructors to lecture and to become 'the sage on stage'. Even now, teacher-centred presentation dominates the classrooms of higher education in China. Many instructors still consider knowledge an entity that they can transfer directly to students. These instructors expect students to listen to and grasp the major 'knowledge points', the main factual and conceptual content of their lectures. This teaching approach reflects the heavy influence of Confucius ethics. The students are influenced too; they tend to be quiet and noninteractive, so as to show their respect for the teacher.

Chinese students' high power distance index (PDI) on Geert Hofstede's cultural dimensions (Wang, 2007) further supports researchers' belief that students in this college prefer less active learning. PDI refers to how people respond to other individuals who hold positions that are superior or inferior to their own (Hofstede, 2001). Specifically, many Chinese students still view instructors as authorities who 'distribute' knowledge. They are more comfortable with hearing the instructors rather than seeing or interacting with them, in person or online (Wang, 2007).

The lack of interactivity is a long-standing feature of Chinese classrooms, whether in online classes or on campus ('ground') classrooms. Many online classes simply provide recorded instructor lectures online or on a CD-Rom, which students study in isolation and passively absorb the content. Some argue that this noninteractive format is no different than the old format of distance learning through correspondence or by watching TV. Distance learning with no interactivity reinforces the negative effects of passive nonparticipatory learning as aforementioned.

The use of mobile learning in this online college represents an attempt to encourage students' active participation in the learning process. It attempts to engage them in constructivist learning through social and intellectual interactions. Throughout this paper, the phrase 'm-learning' refers to active educational content supplied through mobile phones, the most prevalent mobile device in China. m-Learning aligns squarely with this online College's 'learning anytime anywhere' philosophy. Live classes conducted at this college are broadcast online through satellite and the Internet and are also archived for self-paced review. Students can access these live classes by using a laptop, cell phone, pocket PC or any other portable devices. Thus, they are not bound to a classroom to access engaging, well-designed educational content.

Existing mobile learning innovations

In 2005, Thornton and Houser (2005) conducted a broad survey of mobile phone usage on a Japanese university campus. This survey revealed that, despite the ergonomic issues associated with cellular phones, students sent an average of 200 email messages per week from their mobile phones (compared to an average of seven voice calls). Further, these messages contained an average of 200 Japanese characters each (about 70 English words). This phenomenon indicates students' potential interests in mobile learning.

Thorton and Houser then assembled 44 female English as a Foreign Language (EFL) learners. They sent three short text messages containing practice exercises to the learners at predefined times (9:00 a.m., 12:00 p.m. and 5:00 p.m.). The majority of students reported reading all three text messages at once, usually during their commute or during other types of down time. They integrated a valuable learning experience into their daily routine through the use of mobile phones. In addition, the researchers conducted an experiment to compare the efficacy of mobile message exercises to that of paper exercises. They distributed exercises to one group of students via a series of cellular phone messages, and then distributed printed handouts of the same exercises to another group of students. The final scores show that the mobile learners did better on exams. The researchers account for this difference by asserting that students who received cellular messages were 'prodded' into studying more often than those with paper handouts. In this case, 'pushing' educational materials to students produced results.

Discoveries made by cognitive scientists further illuminate the 'pushing' and persuasive effects of mobile learning on learner performance. In an experiment conducted in 1996, Caple (1996) determined that intermittent instruction of small pieces of instruction and periodic practice lead to greater retention by students than large chunks of information and constant practice in a computer-assisted learning environment. This reflects a growing body of work that indicates that small-scale learning interventions and 'spaced practice' allow for the more efficient transfer of knowledge from short-term to long-term memory. Contemporary learning paradigms, such as 'microlearning' (Novak, 2006), seek to promote these benefits and combine them with digital technologies to increase learners' rates of information retention.

Other researchers approach the subject of mobile learning with caution. For example, Harris (2001) promotes a view of mobile learning that values the dual benefits of distance learning and constant connectivity. Wagner and Wilson (2005) advise that mobile learning should not be viewed as 'e-learning' transferred to mobile devices. Instead, they contend, the value of mobile devices as tools of learning is found in the storage capabilities that enable people to connect to previously downloaded materials at any time.

One of the greatest problems encountered by educators and researchers (including Thorton and Houser) is the limitation imposed upon learners by the size restrictions of mobile devices. The small screen size impacts the effectiveness of viewing content (Hayes, Joyce & Pathak, 2004). Moreover, the small keypads do not promote ergonomically satisfying input methods. This limits the primary functions of mobile devices to brief textual communications and the viewing of small chunks of data (Keegan & Univ., 2002). Researchers must keep these technological constraints in mind as they consider how to use mobile devices in large classrooms and blended classes that include both campus-based and online students, as well as how the current curriculum can be adapted or altered for mobile delivery.

m-Learning on a large scale

This study of the Shanghai mLearning system and its implementations aims to gauge learner response to the benefits and challenges of this educational medium towards a goal of shaping further developments. Currently, the penetration rates of mobile devices, especially cellular phones, far surpass that of home computers. Thus, whether we are studying blended learning opportunities or fully mobile learning programmes, the scope of this global trend must factor into our consideration of the utility of this technology.

In China and in many other countries, mobile phones have undeniable potential to expand the accessibility of learning opportunities. But the best practices of using mobile devices in teaching and learning are largely undefined. Systematic studies are needed to investigate students and instructors' experience with mobile learning. Also, studies are needed to examine existing mobile learning programmes to highlight their strengths. Designers should capitalise on these strengths as they develop new mobile learning courses. Future research should also evaluate any potential obstacles to effective communication, such as the appropriateness in using text-messaging language within academic contexts. In so doing, future learning programmes can be designed to minimise these obstacles. Clearly, though, mobile learning's potential is enormous. And the research reported in this paper attempt to address these questions.

A number of early reports on mobile learning have sprung up in the past few years (eg, Ratto *et al*, 2003; Rekkedal & Dye, 2007; Thornton & Houser, 2005). Except a few large-scale projects such as Europe's Mobilearn project (www.mobilearn.org), a great majority of them (eg, personal mobile system, MobileGame prototype) are either prototypes or small-scale interventions that involve a limited numbers of users. The

Wireless Technology Enhanced Classroom built at National Central University in Taiwan (Liu, Wang, Liang, Chan, Ko & Yang, 2003) bears some similarities to the mLearning classrooms we studied, but the Taiwan classroom is still place-bound. Instructors and students have to be in this classroom to use all its wireless features.

m-Learning on a large scale faces the great challenge of creating the concrete context for learning, which 'involves the familiar dimensions of time and location, ... the learner's goals and motivation, the surrounding resources, co-learners, and other available conversants' (Sharples, Corlett & Westmancott, 2002, p. 225). The Shanghai mLearning system we reported here attempts to create a naturalistic context for learning, so as to increase student exchanges in blended classrooms of more than 1000 students. The E-Learning Lab of Shanghai Jiaotong University designed and implemented this mobile learning system that currently supports multidirectional communications in large blended classrooms. This system also helps instructors experiment with more student-centred teaching. The following sections of this paper describe the function and the architecture of the mobile learning system. This article also reports the formal implementation of this system in an English class and its impact on students' learning behaviours, experiences and learning outcomes.

Using mobile devices to teach English language courses is not a new effort. However, most of the current practice targets individual learners and focuses on their access and downloading of learning materials. In studies we reviewed earlier, the mLearning system merely pushed content to students without requiring student–student or student–instructor interaction. The experiment conducted at the E-learning Lab of Shanghai Jiaotong University is unique because this new mLearning system is designed for formal teaching settings and has the potential to affect the 17 000 students enrolled in the online College.

The mLearning system

Figure 1 displays the architecture of this mobile learning system, which includes the mobile phone broadcasting subsystem and the classroom management subsystem. Classrooms are connected to the two servers (broadcasting and management), either through CERNET (China Education and Research Network), a special networking service for high-educational institutions, or cable network through other service providers. Mobile phones can connect to the two servers through the general packer radio service (GPRS) network, a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and computer users.

The successful delivery of course materials to mobile devices needs the cooperation of instructors, students, and system administrators. The instructors use the instructor station to teach in their regular ways, showing a PowerPoint file, writing on the computer screen, writing on the whiteboard on the wall, using a particular computer program, etc. Cameras and microphones connected to the instructor computer capture the live scenes of the classroom. A recording program records all these media compo-

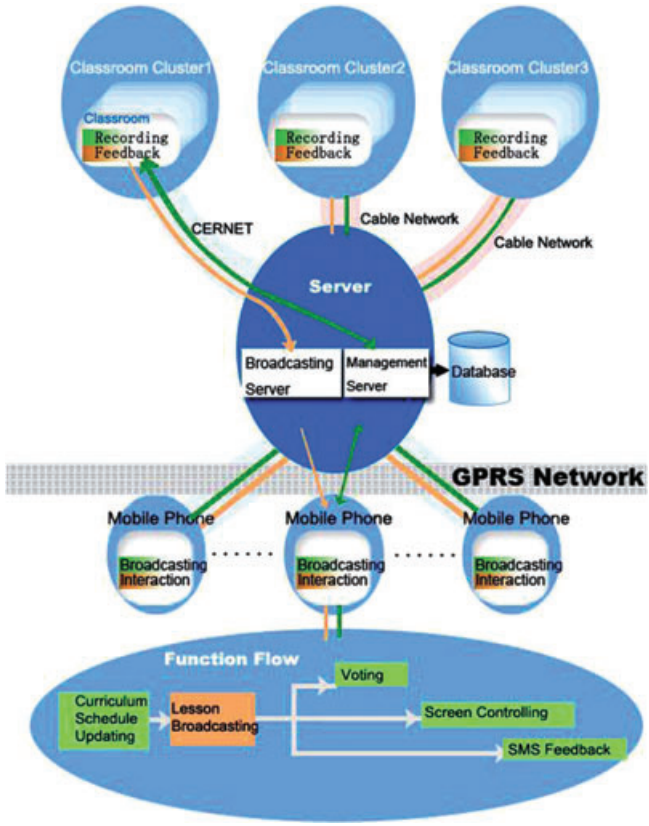

Figure 1: The Architecture of the Mobile Learning System

nents: audio, video, handwriting and any programs or files shown on the computer. Students can tune into these recordings live online, or they can download them later for review.

When the students connect their smart phones to the GPRS network, their mobile devices download and install the client program. Through the client program, students can see the curriculum schedule for that day, as well as all of the classes that are in progress. They can choose which class to virtually attend, and the format in which the live broadcast should be displayed. Once a student's mobile phone connects to a class, the instructor periodically receives a screenshot of the student's mobile device so that the instructor can monitor the student's progress. Meanwhile, students can send text messages to the instructor through cellphone short messaging service. Students' messages will be displayed on the instructor's computer, so as to inform the instructor their learning progress, questions or any other feedback. To address these messages, the instructor can give oral explanations or can reply through short text messages.

Students can also participate in polls and class activities initiated by the instructor. The polls are often related to the various aspects of course conduct, content, pace, clarity, structure, etc. The mobile learning server generates the poll results and immediately sends them to the instructor so that they may adjust or improve the instruction.

When tuning into the live class, students presently have four options: (1) text, audio, and a small video of the real-time classroom, (2) video of the instructor only, (3) enlarged display of the course material shown at that time and (4) a close-up display of the instructor's facial expressions and their body language. Our recent survey shows that 85% of the students prefer the first option, text, audio and video. Catering to this need, the development team is now actively developing courses that can be delivered on the iPhones created by Apple Computers, Inc., in an effort to take advantage of the device's larger screen size and rapid text entry features.

Considering the current lecture-dominated teaching method in China, the researchers concur with the developers' use of a 'tune-in' modality. In addition, Chinese students in general feel a high Power Distance from their instructors (Hofstede, 2001) and the students in this college are no exception (Wang, 2007). Previous surveys with several samples of students in this College all reveal their preference to study alone, by listening to the archived recordings of live class sessions (Wang).

In theory, the text, audio and video mode can create a better context for learning. That is, the feeling of being in a real classroom with the instructor and many other students nearby. Instructors, students, and system administrators cooperate to create a virtual classroom that includes both online and classroom students and the real-time communication between online students and the instructors. However, their cooperation relies on the support of this mobile learning system, which conducts the coding and decoding of the multimedia teaching stream and manages time delays. Aiming to improve the quality of teaching and learning, this mLearning system not only delivers learning materials and live classrooms to mobile devices, but also encourages interactions in large blended classrooms. Its feedback and remote monitoring features also help to ensure the accountability of the distance learning programmes at this college. Figures 2 and 3 show the environmental and technologic configuration of the blended learning classrooms and course display on mobile devices.

Case study: use of mobile learning in a 21st century college English course

This is a descriptive/survey study coupled with qualitative content analysis (Fraenkel & Wallen, 2002) and face-to-face interviews with the course instructor. Online surveys are the main instruments for data collection. The presurvey provided informative data about students' professional background, their experiences in taking online classes, their motivation for taking the class, and their expectations for mobile learning. The postsurvey collected students' experience with m-learning, their perceptions of the mLearning system, their learning process and outcomes. In addition, the researchers used content analysis to analyse text messages exchanged in this class and posts on the class's online forum (discussion board).

Figure 2: A typical 'blended' learning classroom used at this university

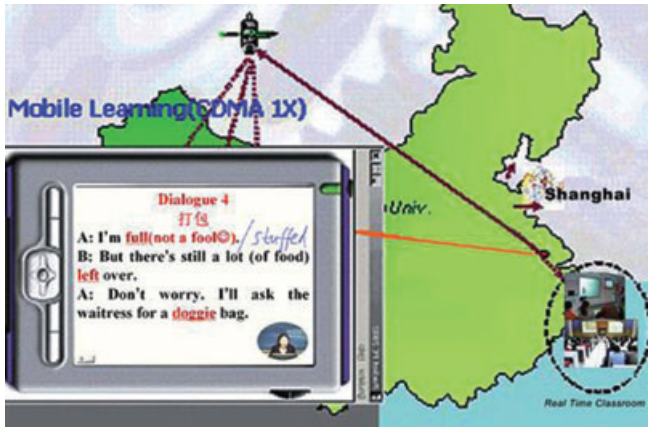

Figure 3: The delivery system and the content and classroom display on a cell phone

The upper-level English class examined in this study mainly prepares students to take a national standardised English test administered to students from distance learning programmes in China. This course also teaches English oral proficiency by asking students to respond to real-life situations with complications. Students must complete three writing assignments, as well as weekly quizzes on vocabulary, grammar and dictation. The class only had one instructor and she taught a 3-hour class every week. Course videos are archived on the class's website, which students can review anytime and anywhere they have access to the Internet.

About 1000 students enrolled in this class. Similar to all other classes offered in this online college, there is no distinction between online and campus students. Students

can choose to study on campus or online anytime during a class session or the semester. Because it is voluntary to attend the live sessions (either face-to-face or online), the composition of both groups changed every week; that is, the membership in either group (campus or online) can vary from session to session. Therefore this is a truly blended class. During the course of this study, an average of 200 students attended classes in the classroom, and an average of 30 students tuned into the live class online. Low presence and scarce participation in live class sessions are common to many classes offered in this online college. As a result of their fast-paced work schedules, a great majority of the students would choose to listen to the recordings.

This case study evaluates the feasibility of promoting language acquisition through mobile learning by eliciting learner responses in a blended English classroom. Not surprisingly, one of the primary considerations for both observers and learners centres on the practicality of using the limited functions of a mobile keyboard to learn and apply new vocabulary. About 585 students (58.5% response rate) replied to the presurvey. About 99% of the 1000 students are working professionals, who take classes from this network college to advance their degree and careers. Because this is an advanced class, many of the students (80%) had heard about the mobile learning system promoted in this College, but none of them have experienced any of the mLearning activities.

Through the mLearning system, the instructor practiced situational dialogues and other interactive activities with students. For example, the instructor showed the exercises in PowerPoint format in her live broadcast, and students (on campus or online) replied within the given timeframe (usually less than 5 minutes) via text messages. The mLearning system displayed these messages on the instructor's computer screen, which the instructor summarised and commented on in class. The mLearning system will also display unsolicited students messages, which the instructor checked periodically and addressed at an appropriate time, either by discussing them during the live broadcast or sending text messages during the break. Because most of the exercises have standard answers, it was not time-consuming for the instructor to summarise the results. The messages that the instructor was unable to address in class were further discussed in the class's online forum (discussion board). These exercises provided formative evaluations of students' progress with the course content, so that the instructor can adjust her teaching methods accordingly. These exercises also assisted students in improving their English vocabulary and understanding sentence structures.

Figure 4 illustrates the before-and-after scenarios of an exercise emailed to students' mobile phones. The instructor filled in the answers later, after students sent in their answers to the questions.

This exercise tests both vocabulary and comfort with idiomatic expressions such as 'live wire'. The technical context, moreover, necessitates proficiency in using the mobile key

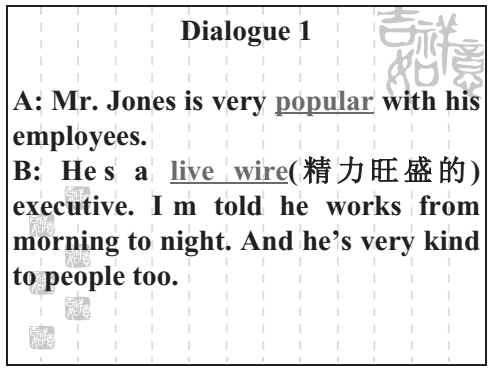

Figure 4: Sample of a dialogue used in class

pad to navigate to the fill-in-the-blank portion of the exercise and to type in the appropriate words or phrases, using the nonstandard variant on the 'qwerty' keyboard designed for use with Roman letters.

Based on the many discussions posted on the forum of the learning management system, the instructor observed students' increased confidence in their English skills. This observation largely recognises students' reaction to real-world scenarios with complications (ie, how to return an item to a store, how to solve problems in daily life). At this stage, the students were far more comfortable with the technological medium than the actual experience of practicing modern, idiomatic English dialogue with native speakers. Thus the mLearn program enables a safe exploration of proper and idiomatic language prior to real-world application. This is not to say that the technical context would be beneficial to learners for whom the medium of communication is a new visual language. However, these observations take into consideration that within the age group and social context of the learners, short messaging services (SMS) are often more common modes of communication than telephone calls. Consequently, the following dialogue practice, borrowed directly from the course materials, is not an unrealistic exchange between classmates/coworkers:

A: You look sleepy. Have you been *burning the midnight oil* recently?
B: Yes. *I've been busy with* the project.
A: But you should *take care of your own health*.
B: *Thank you*. I will.

The cultural context of this exchange perhaps exaggerates the formality and politeness of this manner of dialogue within the English-speaking world, but effectively establishes that such formal exchanges are indeed possible through mobile communications.

Sample replies from the participants

The instructor conducted six activities supported by the mLearning system. The following data (cellphone messages exchanged during class) illustrate the students' progress

throughout the timeline of the course. We selected to report three of the sessions that had lively interactions beyond the standard quizzes. In the three unreported sessions, students simply typed in answers to some of the multiple-choice questions but were not engaged in any other more extensive interactions.

In summary, the instructor received a total of 365 messages from 170 students in these three mLearning activities. A comparison of cell phone numbers tracked by the mLearning system revealed the consistent participation of 110 students. The rest of the students (60) only participated in one or two of the sessions.

A. The first experiment (169 student messages)

The instructor started the class by introducing herself and then the mobile learning activities. In order to encourage participation, the instructor planned to use a reward system—those who actively participated in these activities would either receive bonus points in their final grades or get a registration fee discount for future classes she teaches. Responding to the instructor's introduction, 95 students typed in messages in Chinese without the instructor's prompting. The first 21 messages were all social in nature:

- *love the class, love the teacher*
- *I would like to be the king of text messages in this class*
- *what are the best ways to improve my reading?*

The first academic activity asked students to participate in a practice dialogue about compromise. After showing a sample dialogue, the instructor asked the students to make a sentence using compromise. About 59 students (62% of the class and some of them participated in the introduction activity) responded with good sentences. When the class came to an end, another 15 students sent in unsolicited feedback messages. They are categorised as follows:

- Praising the instructor (five messages): *Your class is lively. This is the first time that I found English interesting.*
- Giving suggestions (one message): *Would you please slow down for me? Thank you for your hard work.*
- Expressing self-confidence (five messages): *I love your teaching style. I think I will lean more about English especially my oral English, thanks.*
- Reporting technical problems (one message): *Your volume is too high. I am hearing an echo.*
- Discussing content (three messages): disagreeing with the instructor about some of the content.

It used to be challenging to elicit verbal responses in large classrooms. Students' exchange of unsolicited messages is quite a breakthrough of the Confucius ethics, which encourages students to listen more and speak less. One could attribute this to a true enjoyment of the class.

Students may also feel more comfortable about sending text messages than speaking to the instructor face to face. Moore and Kearsley's (1996) theory of transactional distance, as a means of measuring and overcoming the 'pedagogical distance' between teacher and learner in distance education, is intended to evaluate the success of course materials in eliciting learner responses at a distance. Mobile learning, however, adds a new dimension to transactional distance. While course materials are presented in the traditional synchronous format, the learner receives these materials at a geographic (if not chronological) difference so that learner autonomy is encouraged and facilitated. Time and distance allow learners to explore a new learning hierarchy where all participants offer input simultaneously, and therefore equally, with no one participant being singled out.

Disagreeing with the instructor in public and giving the instructor suggestions for course conduct are also unusual in classrooms in China. In large classrooms, students often do not have an opportunity to have a personal voice. The use of mobile devices provided students with such opportunities to make their voices heard in real time. In essence, the technology has changed students' learning behaviour.

B. The third experiment (41 student messages)

The instructor began by asking students to talk about their winter vacation. Forty-one students answered. This time, they typed in sentences: I had a good one, a poor one, a fine one, a relaxing one, a busy one, etc.

Three replied:

'*I had a colorless holiday, no trip, no party, just sleeping all day*'.
'*I had a terrific holiday, I stayed in bed late almost every day*'.
'*My holiday was very boring*'.

A few students also used humour: '*I felt it was a wonderful holiday, and the weight I gained proves it!*' '*I'd like to have seven weeks for this vacation, not just seven days*'.

Although the number of participants was small, their interactions were rather meaningful. In this exercise, the normally staid students openly shared their emotions (positive, negative, neutral, etc.) and also were engaged in humorous interchanges. As studies (eg, Wang & Kang, 2006) show, having an emotional connection is the first step in building a learning community.

C. The sixth experiment (155 student messages)

In the sixth experiment, students sent a variety of messages to the instructor regarding their learning experience.

- Answering the quiz questions (151 messages)
- Giving suggestions (one message): *please repeat what you just said.*
- Sharing emotions or concerns (one message): *regrets about having to leave the class early*

- Praising the instructor (one message)
- Blank messages (two messages): *perhaps due to technical error*

It seems that most students stayed on subject and were well prepared to participate. One student, who had to leave early, sent in a mobile phone message, expressing both her regrets and her fondness for the course. The instructor notes this was the first message of its kind she had ever received.

Although 170 participants take up only a minority of all 1000 students in this class, it is a much larger percentage than the other 'regular' classes that do not use m-learning. The 'regular' large blended classes might have more students in the classroom or live online, but they rarely have opportunities to interact with the instructor or their classmates. Because of the exam-oriented assessment system in China's K-12 and higher education, students in regular classes often just study for exams, alone and at the last minute. Finally, considering the novelty of the system, the demand for a high-capacity cell phone, and the work schedule of the students, the number of mLearning participants is reasonable and encouraging.

Analysis of the postintervention survey results

One hundred and seventy-eight students responded to the course's postintervention evaluation (ie, 'post-survey'). Ninety six students replied to the survey within the specified timeframe (two weeks). In order to improve the survey validity and reliability, the researchers extended the timeframe and more students filled in the survey. Of all the 178 respondents, 143 participated in the mLearning activities. Among them, 89 participated in all the mLearning activities and 54 participated 'once in a while'. The rest of the survey respondents (35) did not participate. This trend of noncontinuous participation is attributable to external causes, such as busy work schedules, lack of time, or lack of access to the Internet or a good mobile phone. Among the 35 nonparticipants, 15 said they were not used to interacting with others, while the rest could not participate effectively because of their typing speed on the mobile phone, lack of quiz preparation, lack of knowledge about the question, or preference to focus on the instructor's lecture instead. In response to course organisation, they indicated a desire for instruction to slow down, as well as for increased time to complete the quizzes.

Students reported using their mobile phones in the following class-related activities:

1. discussing course content with classmates (85% of the participants);
2. asking classmates questions (54%);
3. asking the instructor or teaching assistant (TA) questions (90%);
4. answering questions from the instructor or TA (82%);
5. answering questions from classmates; and (52%)
6. exchanging ideas with classmates about the course material (38%).

Interactions amongst students received the highest ranking, with instructor–student interactions (asking questions or answering them) coming in second. This high frequency of student interaction is atypical in Chinese higher education.

When asked if the mobile learning activities they experienced are the same as they expected or imagined, 132 (74%) of 178 respondents said 'yes'. Reasons from the 46 (26%) 'no' respondents include

1. nonparticipation;
2. had to really concentrate on typing messages; did not have time to enjoy the class;
3. the lack of variety of activities;
4. in-class interaction could affect the 'quality' of instruction;
5. Mobile learning needs to better fit students' skills and to meet their needs;
6. slow typing on a cell phone;
7. lack of interactions among the online students.

As the 132 'yes' students perceived, the mLearning system helped to level the playing field for campus and online students, in that online students can also participate and interact in real time. Even though there was not an online chat system for online students to chat or dialogue with the instructor, students could send their questions or comments via their mobile phones anytime during the class. Mobile students seemed to feel a stronger connection to the course material and the instructor than students who sat in the classroom but passively listened to the instructor's lectures. The functions of the m-learning system and students' active use of it made the class interactive and engaging for learners.

Students also gave a handful of suggestions for improving the mobile learning conduct. A large number of students suggested increasing the frequency of class activities and encouraging after-class interactions through email or the class forum. The mobile learning content must have a variety of topics and formats in addition to quizzes and situational dialogues. Students would like to see more real-life content (such as stories) that will teach them how to communicate in an English-speaking country.

The content also appeared too difficult for a small number of students. A few students envisioned more 'cutting-edge' features of the system, for example, the ability to access the quizzes from their mobile phones, and also to see cell phone messages from their classmates. Those who felt concerned about their grades asked for more bonus points for participating in such activities. (The instructor plans to phase out the 'bonus points' system, so that students become intrinsically motivated.)

There was a long and insightful suggestion from handicapped student. He had no access to the Internet at work, and had to attend the class in one of the multimedia classrooms provided by this college. Unfortunately, the classrooms were often so noisy that he could not hear the instructor clearly. He would prefer interactions through emails and the class forum. Learning through mobile phones needs to be coupled with more discussions through emails and forums to accommodate students with special needs. These suggestions reflect the dramatic changes of students' learning behaviours from passive learners to active participants, as well as an increase in their eagerness to participate.

Statistical analyses of the postintervention survey responses

The following are the descriptive statistical analyses of students' responses to the post-survey questions, which are grouped to three categories: (1) satisfaction with the class, (2) satisfaction with mobile learning and (3) satisfaction with class activities. Although the study involves a small sample, the Cronbachs Alpha value ($n = 178$, number of items = 17, $a = 0.9076$) indicates that the reliability of these responses exceeds the >0.90 reliability standard.

As Table 1 displays, QS1, QS16 and QS17 indicate students' satisfaction with the class. QS 3 to 8 and QS15 reflect their satisfaction with class activities; and the rest of the questions (2, and 9 to 14) assess their satisfaction with the overall mobile learning as

Table 1: Descriptive analysis of post-survey responses—student satisfactions (on a scale of 1 to 4)

No	*Question*	*n*	*Mean*	*SD*
QS1 (with the class)	I am satisfied with this class.	178	3.61	0.723
QS2 (with mLearning)	mLearn was organised successfully.	177	3.62	1.364
QS3 (with class activities)	The activities were engaging.	177	3.55	1.525
QS4 (activities)	The activities strengthened my connections with classmates.	177	3.01	0.915
QS5 (activities)	The activities strengthened my connections with the instructor.	177	3.25	0.947
QS6 (activities)	I had more opportunities to ask questions.	178	2.56	1.241
QS7 (activities)	I had more opportunities to help my classmates.	178	3.09	1.142
QS8 (activities)	I had more opportunities to practise what I learned.	178	3.46	0.914
QS9 (m-learning)	mLearn helped me a great deal in studying English.	178	3.57	0.823
QS10 (m-learning)	mLearn helped me grasp the knowledge points (vocabulary)	178	3.19	1.257
QS11 (m-learning)	mLearn helped me grasp the knowledge points (grammar)	178	3.43	1.223
QS12 (m-learning)	mLearn helped me grasp the knowledge points (speaking/oral proficiency)	178	3.07	1.037
QS13 (m-learning)	mLearn changed my habit of studying alone	178	3.44	0.932
QS14 (m-learning)	The modality of mLearn (words, audio, video) fits my learning style	178	3.39	1.012
QS15 (activities)	I felt that my socialsing ability has improved.	178	3.27	1.117
QS16 (class)	I would like to recommend mLearn to other students.	178	3.50	1.028
QS17 (class)	I (very much) would like to participate in future mLearn activities.	178	3.56	0.986
Valid *n* (list wise)	95			

used in class, from organisation to conduct, to its impact on their learning. The mean ratings of students' satisfaction with this class are high, ranging from 3.50 to 3.61. The high ratings for QS16 ('I would like to recommend mobile learning to other students') and QS17 ('I would like to participate in future mobile learning activities'), reveal that, in general, students are satisfied with the class and would like to take part in other mobile learning classes or recommend this class to other students. QS1 has the highest mean result of all questions, which indicates students' high satisfaction with this class.

The results for 'satisfaction with activities conducted in this class' were positive, with means ranging from 2.56 to 3.55. QS3 to QS5 and QS15 are related to the connectivity between students and other classmates and the instructor. QS6 to QS8 pertain to satisfaction with the learning activity content and the collaborative aspects of the learning activities. QS6 ('I had more opportunities to ask questions') received the lowest mean value (2.56) compared to other question results. This suggests that improved methods are necessary for facilitating student interactions with the instructor. Meanwhile, the students expressed a high degree of confidence (3.27) that the class activities helped them to socialise while the course content empowered them to learn.

QS 2 and 9 to 14 pertain to 'satisfaction with mobile learning,' ranging from 3.07 to 3.62 in the results. QS 9 to 12 concern the contents of mobile learning and this method of content delivery. QS13 and QS14 are related to the appropriateness of mobile learning to learning style of students. This category received the highest ratings compared to the two categories shown earlier. This is very meaningful in that the students showed a strong interest in mobile learning and this method of learning content delivery. The highest mean is 3.62 on the answer to QS2, showing that the class is very organised and makes good use of the m-learning delivery system.

Although 10 of the standard deviations for the 17 questions are larger than 1 (they should not exceed 1.00 with a small sample), Cronbach's alpha confirms the reliability of the Likert-scale ratings of the postsurvey, that is, students' perceptions of mobile learning activities (the 17 questions in Table 1). Therefore, the survey questions yield reliable results, and the student responses appear to reflect their satisfaction with this course.

Analysis of posts on the class forum

About 282 students posted about 1923 messages on the English course's online forum. Compared to other classes, these numbers are phenomenal. Due to the system limitation, it is not feasible to count how many messages the mLearning participants posted. However, a name search and matching indicate that 140 of the 170 mLearning participants posted on the forum. Table 2 contains the coded and organised categories of topics, as well as the corresponding number of responses to each kind of topic. Student discussions are grouped into four major pedagogic categories:

Table 2: Coding table for the online forum and frequencies

Coded Topics (Selected)	*Number of Responses*
A) Course Logistics: topics related to practical classroom functions such as grades, books, practice, and attendance	968
1. Training	598
2. Examination results	48
3. Attendance policies	25
4. Requests for information about reference books	25
5. Misc. course logistics	113
6. Notification of guest speakers	69
B) Curriculum and content (course presentation, materials, problem solving):	476
Discussing course presentation: Topics related to the instructor's presentation of course content within the classroom.	315 (226 are exam-related)
Discussing course materials: topics wherein students discussed assignments, course content and asked questions about course materials	149
1. Discussing assignments	37
2. Grammar	26
3. Translation	75
Solving problems in English: the instructor introduced this topic to inspire students to attempt to solve riddles that using English idioms. In this topic, the instructor asked: 'What has a head and a tail, but no body'.	12
C) Learning Support: student requests for help with course content or emotional support (such as encouragement).	259
1. Requests for help with course content	252
2. Requests for emotional support	7
D) Students' response: feedback from students to instructor, socializing, expressing emotions, exchanging information, setting goals, encouraging oneself	280
Feedback for instructor: topics wherein students gave feedback to the instructor and requested specific types of content for future lessons	135
1. Requests for content	3
2. Gratitude for instructor	32
3. Praise	88
Socialising: topics that contain instances of noncourse-related student interactions	62
Expressing emotions: topics wherein students posted emotional responses towards other students or excitement about learning	47
1. Gratitude to peers	10
2. Spontaneous display of excitement	16
3. Excited about coming semester	5
Exchanging information: topics wherein students traded information about websites, optimal study methods and newly discovered sources of information	20
Encouraging oneself: A pair of students attempted to bolster their confidence in a short exchange	2
Setting goals: In these topics, students set goals for themselves and displayed a great deal of enthusiasm for learning English	14

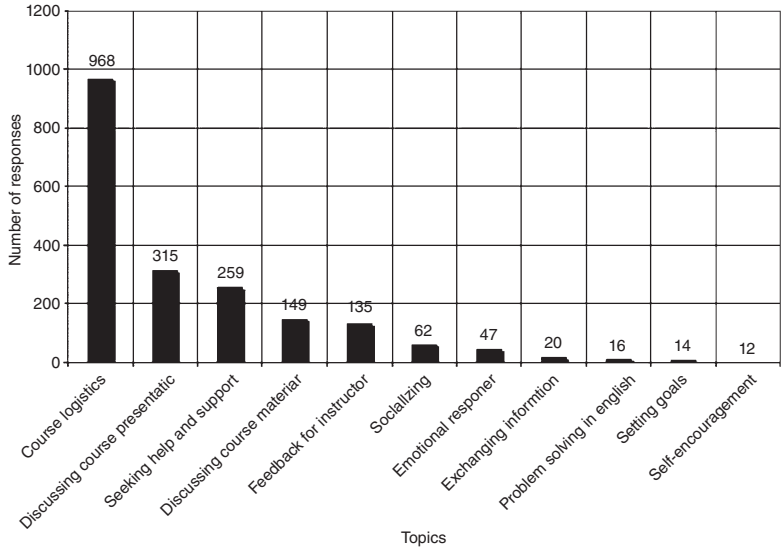

Figure 5: Bar Graph: Frequencies of Occurrence of Forum discussion topics

1. *Course Logistics* (968 posts): Topics related to practical classroom functions such as grades, books, practice, and attendance;
2. *Curriculum and content* (476 posts): course presentation, materials, problem solving;
3. *Learning Support* (259): Student requests for help with course content or emotional support (such as encouragement); and
4. *Students' response* (280): feedback from students to instructor, socialising, expressing emotions, exchanging information, setting goals and encouraging oneself.

As is shown in the frequency distribution (Figure 5), a great number of the forum interactions fell into common, noncontent-related categories such as course logistics and feedback regarding the course's presentation. This allowed students to ask questions about attendance policies, reference books, and examinations results without interrupting the live class. Time shifting of noncontent-related questions often appears in distance learning and blended classrooms.

Instructors expect students to use the forum as a sounding board for their ideas and questions. However, researchers did not anticipate the level of personal investment that a close reading of the forum posts uncovered. In some of the posts, students set personal goals such as: (1) to pass an English proficiency test, (2) to learn English as well as the instructor has learned it, and (3) to study hard under the guidance of the instructor.

Further, a small group of students publicly expressed their emotions about this class, the instructor, and the coming semester. This is uncommon in Chinese classrooms. Among the 47 codes in sharing emotions, 21 of them are spontaneous display of excitement about taking this English class with this particular instructor and about

meeting her in person; 10 of them are gratitude for assistance from classmates, and the remainders express confidence in passing the national English proficiency exam, regrets about not being able to attend the classes in person, and regrets about failing another proficiency test.

Researches show that emotions and imagination are integral to the process of adult learning (Wang & Kang, 2006). In their Cybergogy for engaged learning model—theories about creating engaged learning online, Wang and Kang (2006) identified four kinds of feelings that might affect learner engagement: (1) feelings of self, (2) feeling of interpersonal connection/community, (3) feelings of learning atmosphere, and (4) feelings emerging from the learning process. Students' text messages, post survey responses and forum posts showed the appearance of all four types of emotions in this class.

There are also two posts, where students encourage themselves to improve English proficiency a great deal during this class. Goal-setting and self-encouragement indicate that students have invested themselves in learning the course material. Rather than simply going through the motions of participating in a class, these students have taken responsibility for their own learning and their own success. This is an indication that m-learning, coupled with more traditional distance learning techniques, can much better engage students in the learning process. Students in this class changed from passive learners to truly engaged learners who are behaviourally, intellectually, and emotionally involved in their learning tasks. According to Wang and Kang's Cybergogy model for engaged learning online, allowing students to set their learning goals could boost motivation, thus encouraging their immersion in the learning process.

Use of m-learning also changed the instructor's perceptions of teaching and learning. First, she intentionally prepared more interactive activities to replace stand-up lectures. Second, she learned a great deal from the students, in both content and teaching methods. Finally, she enjoyed the class more because of the large number of active participants, as opposed to quiet and attentive 'bodies'.

Conclusion

The mobile learning system described in this paper is innovative in the following ways:

1. Using a Smart Phone Platform, the system broadcasts real-time classroom activities—including video, audio, lecture notes and hand writings—, to students' mobile phones via the GPRS network. During this broadcast, all activities occurring in a real classroom are synthesised onto the mobile phones and are then played back in real time. Based on the students' GPRS network conditions and their preferences, they can customise how to receive the broadcast (audio, video or text).
2. This mLearning system enables the instructor to monitor all online students' mobile phone screens without too much delay, so as to facilitate instructor supervision of students' learning activities and to provide guidance when necessary. The system also provides several teaching-assisting mechanisms such as real-time poll and

text-messaging exchanges, which enable instructors and students to communicate freely and timely for better teaching and learning.

The use of this system in the English class has been successful on several levels. The pedagogic approach, which viewed mobile learning as a device for promoting interactivity in a traditionally culturally didactic learning environment, fared well in eliciting active student participation. It is delightful to see the change in students from passive learners to active participants, and to see their voluntary engagement in the learning process. The use of m-learning activities in this class reveals the power of the mLearning system as persuasive technologies (Fogg, 2003), that is, technologies can be used to change people's thoughts, feelings and actions. It has also produced results that align with the engaged learning model (Wang & Kang, 2006), which promotes engaging students in learning from all three aspects—cognitive, social and emotive. Meanwhile, the course content revealed itself to be well-suited for text-based interactions that explored language usage in its traditional and colloquial/idiomatic forms. The practice of situational dialogues effectively simulated real-time dialogues in which students had limited time to recall and enter the appropriate word.

This m-learning case study leads to a few implications for designing and conducting future mobile learning courses: (1) A thorough orientation is needed to help students understand the scope and format of m-learning activities. Students need to get 'hooked' in the first class session, and they need continuous encouragement to stay involved. A reward system is necessary at the beginning but instructors should aim for students' self-motivation afterwards. (2) m-Learning is better suited for short activities that do not demand intensive reading and individualised feedback. (3) Considering the large amount of forum discussions on course logistics and other noncontent-related topics, instructors should consider conducting a course Q-A in class through the m-learning system. m-Learning should also be used to address topics that students are keen about. (4) Activities are needed to facilitate students' interactions with their classmates through the m-learning system.

However, much work remains to be done. Technology-wise, the delivery of video and audio streams can use some improvement. In addition, audio interaction should be an option in this mobile learning system. This solution can help alleviate the problem of slow typing on a mobile phone. Language classes, especially, would benefit from an audio enhancement enabling listening and speaking practice under the teacher's guidance. Responding to students' request for better using the class forum for discussion, the next version of this mLearning system needs to include a broader spectrum of distance learning features, such as supporting students' access to the forum messages (reading and posting) with mobile devices. As researchers uncover solutions to these problems, mobile learning will provide greater access to education for all, regardless of geographic location, technological means or chronologic limitations.

Most importantly, while this paper is being written, definitions of mobile learning have shifted their focus from the mobility of the technology to the mobility of the learner.

Accordingly, researching mobile learning requires studying: '... how the mobility of learners augmented by personal and public technology can contribute to the process of gaining new knowledge, skills, and experience' (Sharples, Sánchez, Milrad & Vavoula, 2007, p. 3). This multidimensional view of mobility greatly enriches the discourse in mobile learning and also poses new directions for research. In addition to further developing and studying the m-learning system, our future work will examine learner mobility in physical, conceptual, and social spaces. We will also explore how to better design learning materials to cater the intricacies of mobility, and how to better facilitate learning in large blended classrooms.

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