

DOI: 10.1145/1498765.1498803

BY EUSEBIO SCORNAVACCA, SID HUFF, AND STEPHEN MARSHALL

Mobile phones in the Classroom: If You Can't Beat Them, Join Them

CLASSROOM INTERACTIVITY HAS A NUMBER OF significant benefits: it promotes an active learning environment, provides valuable feedback for lecturers, increases student motivation, and enables a learning community.⁶ On the other hand, interactive activities for large classes (over 100 students) have proven to be quite difficult and, often, inefficient.³

During the past six years the rapid proliferation of mobile devices, particularly cellular phones, has presented an opportunity to develop new interactive classroom systems which have the potential to enhance students' learning experience.^{8,9,11}

The present challenge for researchers is to go beyond anecdotal perceptions and obtain empirical evidence about the impact of these technologies in the classroom. This paper describes a novel application of short-message-services (SMS) for large-class

interactivity, and assesses its impact on the learning experiences of 1200 students in a large undergraduate class.

The traditional lecture theatre environment has provided universities with a cost effective and scalable means of teaching students. However, this has come at the price of making interaction difficult and inefficient, leading to reduced student engagement, motivation and learning.³

Classroom Feedback Systems (CFS) provide one possible technological mechanism that can efficiently enable interaction in large classes. Known by various names (e.g., "clickers") and produced commercially by a range of vendors, CFS technologies have been used since the sixties to allow students to respond to questions and have the results processed and displayed for use by the lecturer and the class as a whole.^{5,7} The more sophisticated CFSs provide the ability to answer a range of question types, from simple yes/no through to detailed responses, free-form questions and role-playing. Current platforms range from small infra-red units, through radio units, to the use of Web systems accessed by wireless personal digital assistants (PDAs) or laptops.^{5,7}

These systems are generally well regarded by students when they are used. Numerous case studies have described the use of CFS technologies in disciplines ranging from the physical sciences through mathematics, accountancy and literature.^{2,3,4,6} A variety of positive outcomes from the use of CFS technologies have been reported including improved understanding of important concepts,^{6,7} increased student engagement and participation,^{3,7} improved quality of discussion in the classroom⁷ and improved teacher awareness of student difficulties.⁷ A clearer perception of their students' current level of understanding allows instructors to adjust their teaching appropriately.

However, CFSs are not a panacea. Using CFS technology without specific pedagogical changes appears to have no benefit on student performance and learning outcomes, despite the

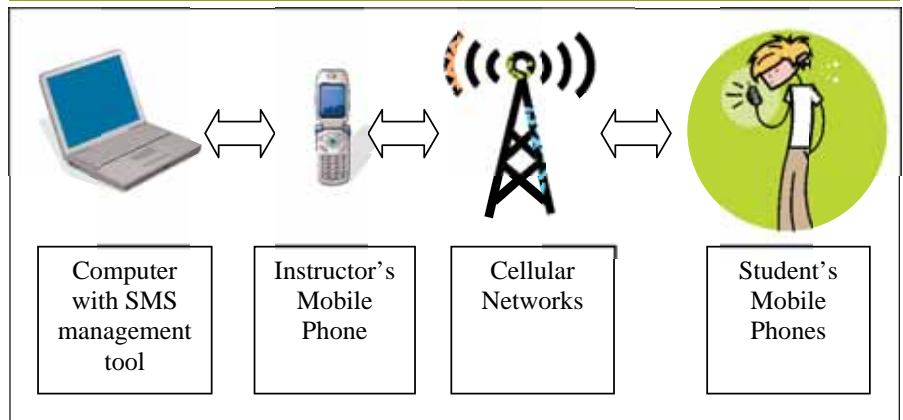
positive perception of the technology reported by the students.^{1,5,7} It is clear that asking questions like “do you understand this” does not result in useful outcomes for either the student or the lecturer.¹ Penuel⁷ contends that the CFS technology does provide a vehicle for positive change, but such change will only occur if the actions of the teacher using the technology changes the culture of the classroom in a such a way as to support the student’s engagement and peer interaction.

The use of CFS hardware also introduces some difficulties for students and institutions. Historically, CFS systems depended on a significant wired infrastructure that had to be built (or retrofitted) into lecture theatres.⁵ The introduction of wireless units has helped reduce that limitation, but necessitates that students either own or rent their own units, or a unit must be provided to each student in the lecture. Either approach has problems, with students either losing or forgetting the units, or institutions needing to provide teaching assistants who hand out and collect units in class.² Requiring students to purchase the hardware, even in environments where deals are made with textbook publishers to subsidize the equipment, can be problematic for student budgets.

Another approach involves the use of personal Web-enabled devices such as PDAs or laptops. The larger display and more flexible programming environment of these devices potentially enable a rich set of student feedback, but this comes at the price of problematic issues such as battery life, complicated and unreliable wireless configuration, and technical incompatibilities. There is also a problem, shared with laptops, that these devices increase the temptation for students to engage in off-task activities such as internet browsing or online chatting.¹² And of course many students may not be able to afford the devices at all.

In the New Zealand context, despite rapid growth of wireless internet access, only a minority of students own portable devices such as PDAs or laptops. The preferred mobile communication device is undoubtedly the mobile phone – which has passed the 90 percent penetration mark.¹⁰ As with most of the world, mobile phone

Figure 1. TXT-2-LRN Infrastructure



ownership and the use of short message service (SMS) communication has rapidly increased over the past five years. Mobile phones are regarded as essential devices by the student demographic and have the advantages of being familiar, permanently configured to work correctly, and battery lives generally measured in days rather than hours.⁹ Thus, as a platform for a classroom feedback application, the mobile phone enjoys a level of ubiquity and ease-of-use substantially greater than that of other types of devices.

The potential advantages of mobile phones as educational devices enabling mobile learning outside the physical classroom are well described in the literature.⁸ Generally these have been aimed at the mobile professional, engaging them in informal or on-demand learning.⁹

The TXT-2-LRN System

The development of the TXT-2-LRN (text-to-learn) system is based on the assumption that nowadays most students have an SMS-enabled mobile phone with them in the classroom. In order to take advantage of this available “infrastructure,” an instructor must be able to receive messages from students while lecturing. A very simple solution was developed: a mobile phone connected to the instructor’s laptop and the installation of a SMS management tool (SMS Studio). Other approaches are also possible, for example, an SMS-gateway instead of the phone. The SMS software enables the instructor to easily read incoming SMS messages on the computer screen as well as automatically analyze the results of polls. In addition, it also allows the instructor to

send messages to any mobile phone. Figure 1 presents a diagram of the system’s basic infrastructure.

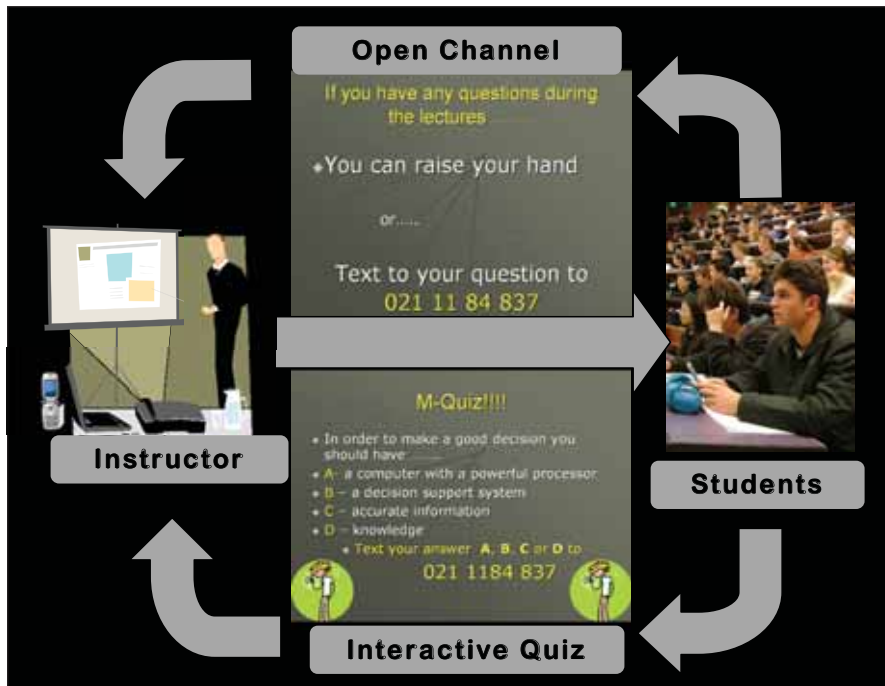
Based on the literature review described above on mobile technologies, ICT in the classroom and pedagogy, two new classroom dynamics were designed:

Open Channel allows students to send questions or comments to the instructor’s laptop via SMS without interrupting the class. The instructor is able to read the messages on the laptop screen and decide whether and when to comment on the message received. Replies to questions that were not addressed during class could then be supplied by the instructor afterwards via SMS or a traditional discussion forum.

M-quiz. During the class, the instructor presents a slide containing a question related to the topic, with four possible responses (A, B, C, D). Students discuss the question and then use their mobile phones to select an answer. A real-time graphic display showing the aggregated results can be displayed on the main screen. This feature is used mainly for concept tests⁶ or to trigger class discussions.

Figure 2 summarizes the classroom process using TXT-2-LRN. At the beginning of each lecture, a slide is presented reminding students that if they have a question or comment they may raise their hand or send an SMS. (Students are informed at the start of the class that by sending a message their mobile phone number would be disclosed, however their identity would remain anonymous.) The instructor’s mobile phone number also appears in a corner of all remaining presentation slides. An interactive quiz can be injected at appropriate points during the lecture. Students can

Figure 2. TXT-2-LRN Classroom Interaction



send the instructor SMSs during class was useful. The instructor involved in the trial had a very positive experience using the system and perceived a notable increase in quality and quantity of student feedback during class. In addition, the number of comments and questions received via the system (about 15 per class) was valuable without being disruptive. The instructor was able to easily manage the student messages by chunking them together and reviewing them at class “check-points,” the points during a class when the instructor pauses, asks (verbally) whether there are any questions or comments, then proceeds to the next topic or segment. Overall, approximately 130 students at some point during the five lectures actively contributed with comments or questions. That is a substantial improvement for a large class environment, where students are normally passive listeners.

Why did 75% of students not use the open channel? Many (42.5%) responded that they had nothing to say. A small number (4.6%) felt that doing so would be distracting. Surprisingly, quite a few (33.6%) gave cost as the main inhibiting factor. Approximately 40% of the Vodafone subscribers indicated cost was a factor, compared to just 26% of Telecom subscribers – a highly significant difference ($\chi^2 = 13.96, df = 4, p < 0.7\%$)

Participation in m-quizzes was higher than use of the open channel: more than half of the students took part in at least one m-quiz and 80% of them perceived that the m-quizzes were useful. The instructor noticed that m-quizzes provided several benefits, including instantaneous feedback on concept tests or using m-quiz results to stimulate class discussion. It was also noticed by the instructor that students seemed to be very interested in the result of polls that reflected their collective opinion on a given issue. In the case of the m-quizzes, student participation was mainly inhibited by cost (55%), and to a lesser extent by lack of interest (20.7%).

Impact on Students' Learning Experience

The student learning experience is the totality of the student's interactions with the instructor, other students and the aspects of a course that influence (either positively or negatively) their

answer on their own, or can be invited to discuss their answers with the people next to them before responding.

Please Turn Your Mobile Phones “ON”

FCOM110 is a mandatory course for all Bachelor of Commerce and Administration students in Victoria University of Wellington, New Zealand, introducing them to major areas of business (including IT). Approximately 1,200 students take this course, one of the largest cohorts in the university. One-hour lectures are delivered three times a week to four streams of 300 students. Recently, during the five lectures on information technology, students were introduced to the TXT-2-LRN system and actively encouraged to use their mobile phones in class (in contrast to many courses where they are told to turn off their mobile phones!). During the trial, using the system was voluntary and students paid for their own messages. At the end of the fifth lecture, 600 students were randomly selected to answer a survey containing 22 questions measuring mobile phone usage, user acceptance of the system, and perceived impact on students' learning experience. A total of 569 valid questionnaires were returned (a 95% response rate). The questionnaire was developed in conjunction with Victoria University's Teaching De-

velopment Centre, and received face and content validation.

Results

The sample was distributed approximately equally by gender (52.7% female, 47.3% male), mostly aged between 18 and 22 years (72.9%), predominantly in their first year of studies (68%), and mainly native English speakers (64%). Most students (79.3%) attended all five lectures involving the trial.

Almost all students (96.8%) owned a mobile phone that they normally had with them during classes. Most students (64.9%) sent more than 14 messages per week and spent on average \$35 per month on mobile phone services. New Zealand has two mobile phone operators that offer quite different price structures for their SMS services. Vodafone NZ charges \$0.20 per SMS, while Telecom NZ offers a flat rate of \$10 per month for up to 500 messages. In our sample, despite the price difference favoring Telecom for heavy SMS users, Vodafone's market share was slightly greater (54.5%), and a large majority of students (82.8%) used pre-paid cards instead of a monthly plan.

During the trial, approximately a quarter of the students used the open channel to send a question or comment in classes. However, over 90% of students perceived that the ability to

learning. While not the same thing as learning outcomes, some aspects of a student’s learning experience are related to his or her learning outcomes.^{3,6}

Using a set of Likert-scaled questions with responses ranging from 1 (strongly disagree) to 5 (strongly agree), students provided their perceptions regarding usefulness and effectiveness of the TXT-2-LRN system. Reliability analysis was carried out to investigate the internal consistency of the scale used in this part of the questionnaire (Cronbach’s alpha = 0.92). Results are presented in Table 1.

The results clearly indicate that students felt that TXT-2-LRN increased class interactivity, increased their interest level in both the classes and (to a somewhat lesser extent) the subject material, and overall was a useful and enjoyable addition to the classroom process. A non-parametric sign test showed that the mean response to each of the first six questions was statistically significantly (at $p < 0.001$) greater than the neutral point on the scale.

These results are in general agreement with other applications of CFS technology noted in the literature review, in particular increased engagement and interactivity, improved classroom discussions and the ability of the instructor to react to the student’s feedback effectively.^{3,7} The perception that the system had less impact on their interest in the subject itself is also consistent with many other studies.^{1,5,7}

Response patterns were analyzed for co-dependence to determine the existence of socio-demographic effects. Gender, age, year of study, and mobile phone usage intensity showed no significant co-dependence. However, students’ native language not being English was a significant variable. Our expectation was that English-second-language (ESL) students would find the system more useful than native English speaking students. This assumption was based on the idea that most of the ESL students would be more comfortable interacting via the SMS channel as it would make it easier for them to express themselves clearly. Surprisingly, the result of the analysis found that native English speakers had a significantly more positive overall perception of the system than their ESL counterparts.

Table 1. Top Ranked Impacts of TXT-2-LRN in the Classroom

Questions	Mean	Sd	Rank	Sig.
Using txt messages increased the levels of interaction in class.	4.05	1.02	1	$p < 0.001$
Using txt messages during class made the classes more interesting.	4.04	1.00	2	$p < 0.001$
Using txt messages in the classroom is a good idea.	3.83	1.06	3	$p < 0.001$
I found this interaction method effective.	3.76	1.03	4	$p < 0.001$
In general, I liked using txt facilities as part of this course.	3.67	1.10	5	$p < 0.001$
I would like to see more use of txt facilities to assist my studies.	3.67	1.09	5	$p < 0.001$
The use of txt messages during class increased my interest in the subject.	3.58	1.06	6	$p < 0.001$
The use of txt messages during class enhanced my study.	2.95	1.01	7	—

Students were also asked to indicate their preferred method of communication if they would like to ask the lecturer a question (traditional vs. SMS). As shown in Figure 3, SMS is the strongly preferred method of communication for asking questions.

Finally, students were asked for their opinion regarding the class size that this system would be mostly appropriate. Approximately three-quarters of the respondents believed that TXT-2-LRN should be used mostly in large classes.

Conclusion

The rapid proliferation of mobile phones among the student population has provided a novel platform for the development of classroom interaction systems. This study has shown that both students and instructors can benefit from an additional channel of

communication – SMS messages via mobile phones - in the classroom. The lecturer perceived a gain of quality and quantity of feedback from the students. Students indicated that the system was useful - making classes more interesting and interactive. The “open channel” was found to be an especially useful, efficient and preferred method of communication, in comparison to the traditional “raising hands” method of asking questions, which is increasingly impractical as class sizes grow. While students perceived only a moderately positive impact of the system for increasing their interest in the subject and enhancing their study, they indicated that they would nevertheless like to see more use of this technology in the classroom. The main inhibitor for adoption of SMS in the classroom was the cost of text messages. Competitive forces driving

Figure 3. Preferred Method of Communication



changes in the pricing structures offered for SMS services should see this barrier reduced in the future.

This study has focused on students' overall learning experiences using TXT-2-LRN in a traditional classroom setting. Further research should be undertaken to better understand the impact of such approaches on students' specific learning outcomes (as opposed to their more general learning experiences). In addition, studies could examine the use of TXT-2-LRN beyond the boundaries of the classroom, or the institution.

The use of mobile phones in the classroom has the potential to increase some negative outcomes or distractions such as phones ringing during class or students engaging off-task activities (e.g. sending messages to their friends). However during the TXT-2-LRN trial these issues were not experienced or perceived by the instructor. Nowadays, the reality of the large classroom is that most students have their mobile phones switched on (usually on silent mode) and that occasionally they exchange messages with their social network during class (usually trying to hide the device under the table). Our experience has shown that positive results can be achieved by encouraging students to bring their mobile phones out in the open and to use them to contribute to the class, and to their own learning – that is, by joining them instead of trying to beat them. ■

References

1. Blodgett, L. D. The effects of implementing an interactive student response system in a college algebra classroom. The University of Maine, 2006.
2. Draper, W. S., and Brown, I. M. Increasing interactivity in lectures using an electronic voting system. *Journal of Computer Assisted Learning* 20, 2004, 81-94.
3. Freeman, M., and Blayney, P. Promoting interactive in-class learning environments: A comparison of an electronic response system with a traditional alternative. *Proceedings of the 11th Australasian Teaching Economics Conference*, 2005.
4. Hall, H. R., Collier, L. H., Thomas, L. M., and Hilgers, G. M. A student response system for increasing engagement, motivation, and learning in high enrollment lectures. *Proceedings of the Eleventh Americas Conference on Information Systems*. (Omaha, NE, USA Aug. 11-14, 2005).
5. Judson, E., and Sawada, D. Learning from past and present: Electronic response systems in college lecture halls. *Journal of Computers in Mathematics and Science Teaching* 21, 2002, 167-181.
6. Mazur, E. J. *Learning and Behavior*, 4th ed. Prentice Hall. Upper Saddle River, N. J. 1998.
7. Penuel, R. W., Roschelle, J., and Abrahamson, L. Research on classroom networks for whole-class activities. *IEEE International Workshop on Wireless and Mobile Technologies in Education*, 2005, 222-229.
8. Schwabe, G., Göth, C., and Frohberg, D. Does team size matter in mobile learning? *Proceedings of the Fourth International Conference on Mobile Business*. IEEE Computer Society, Sydney, Australia, 2005, 227-234.

9. Scornavacca, E., Barnes, J. S., and Huff, S. Mobile business research published in 200-2004: Emergence, current status, and future opportunities. *Commun. of the Association for Information Systems* 17, 2006, 635 - 646.
10. Scornavacca, E., and McKenzie, J. Perceived critical success factors of SMS based campaigns: A managerial perspective. Presented at European Conference on Information Systems, Gotheburg, Schweden, 2006.
11. Sheng, H., Nah, F. F-H., and Siau, K. Using wireless technology to facilitate learning: A grounded theory approach. Presented at 11th Americas Conference on Information Systems, Omaha, 2005.
12. Ward, R. C., Reeves, H. J., and Heath, P. B. Encouraging active student participation in chemistry classes with a Web-based, instant feedback, student response system. In *CONFICHEM: Non-Traditional Teaching Methods*, 2003.

Eusebio Scornavacca (Eusebio.scornavacca@vuw.ac.nz) is a Senior Lecturer in the School of Information Management, Victoria University of Wellington, in Wellington New Zealand

Sid Huff (sid.huff@vuw.ac.nz) is Professor of Information Systems and Head of School, in the School of Information Management, Victoria University of Wellington, in Wellington New Zealand

Stephen Marshall (Stephen.marshall@vuw.ac.nz) is a Senior Lecturer and educational technologist in the University Teaching Development Center, Victoria University of Wellington, in Wellington New Zealand

© 2009 ACM 0001-0782/09/0400 \$5.00

Copyright of Communications of the ACM is the property of Association for Computing Machinery and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.