USING SHORT MESSAGE SERVICE (SMS) TO ENHANCE TEACHING AND LEARNING

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Abstract

In October 2008, a pilot study using Short Message Service (SMS) to deliver quizzes to 14 students studying statistics at an Australian University was conducted. Data collected and analysed from the pilot included student responses to the quiz questions as well as their evaluation of the learning experience, measures of their approaches to learning, and attitudes to computers. The results from the pilot support the efficacy of using SMS to encourage students to engage with material outside of class and suggest that student learning is enhanced as a result.

Using Short Message Service (SMS) To Enhance Teaching and Learning

Short message service (SMS) has been used effectively in a number of ways in educational settings. Although the main applications have been administrative, such as sending students information about enrolment and exam results, SMS has also been used to encourage peer support and assist students' transition into university life (Harley, Winn, Pemberton, & Wilcox, 2007). These sorts of applications are not intended to enhance learning specifically, although SMS could

potentially be used in a number of ways that *would* quite directly impact on and enhance student learning. In this paper, we both describe a specific application for SMS that is designed to improve students' learning and present the results of a pilot study using text messages to deliver quizzes to students studying research design and statistics. From the evaluation of the pilot, we are able to recommend using SMS to encourage students to engage with material outside of class, as well as providing suggestions for future research on SMS as a teaching and learning tool.

Research reports confirming the effectiveness of SMS as an e-learning tool have begun to appear in the literature, alongside those describing teaching support and administrative applications for this technology. There are several reports emerging from a range of discipline areas using SMS to enhance learning from mathematics and teacher training to teaching languages. Thornton and Houser (2004) used SMS to send mini-vocabulary lessons to Japanese University students learning English. Words to be remembered were placed in an elaborative sentence that methodically built students' comprehension of vocabulary. For example, students were sent an SMS with the message "Today's word, vision, is the same as eyesight. Do you have good vision or do you have to wear glasses?" Words were sent at three, fixed time periods per day to encourage spaced rehearsal. Those students who learnt vocabulary via SMS recalled significantly more words at test compared to students who learnt using a computer or paper methods. In addition, these students reported that they preferred receiving the vocabulary via SMS compared to the other methods and that they did not believe that mobile phone screen size had inhibited learning.

Another application of SMS to enhance student learning has been reported by Hagos (2008) who developed mini mathematics lectures delivered via SMS to make use of downtime students experience when lecturers are late for class, absent or unable to interact with them. These lecture-texts were designed to promote flexible, self-paced learning and be easy to use. The text messages consisted of mathematics problems sent to students by the lecturer, students then solve the problems and send their solutions to the lecturer before the next class. A total of 90 students responded to the Hagos's evaluation of the lecture-texts, indicating satisfaction with all aspects of the experience using SMS to learn mathematics concepts. These students also reported it was convenient to study in this way and that it provided opportunities to review concepts when it suited them. Although no data was provided on how well the students learnt with this method, the evaluation findings indicate that the students found working with the lecture texts stimulating and motivating.

Cheung (2004) used SMS in his microeconomics classes to allow students to participate in simulation games to demonstrate the properties of markets and

models in economics. In these learning activities, students were individual decision makers in an economic interaction based on theories studied in class. Afterwards they analysed the patterns of behaviour seen in the interaction and evaluated the outcomes. The use of SMS streamlined data entry and collation, facilitating reporting of results and provision of individual feedback. These classroom experiments provided a bridge between the subject matter of microeconomics and the real world. Using SMS to deliver the classroom experiments made them easy to incorporate into lectures and promoted interaction between students.

The usefulness of SMS for managing interactions between supervisors and trainee teachers was demonstrated by Seppala and Alamaki (2003). Photographs of teacher training events and learning activities taken by students with a digital camera were downloaded to a shared database and then uploaded to a mobile device. Students and supervisors made comments and observations about the pictures via SMS. With no face-to-face interaction occurring, the use of SMS in this way created a virtual collaboration between peers and supervisors. Evaluation of this experience showed that students and teachers were positive about the benefits of convenience, immediacy and increased interactivity of learning. An example of using SMS to support student-to-student communication and collaboration is the SMS application developed by Silander, Sutinen, and Tarhio (2004). This application was used by students to engage in collaborative concept mapping of tree species. Students out in the field used SMS and script language to add concepts and relations about tree species to a database managed by students in the classroom using wireless laptops. The students worked collaboratively inside the class and out in the field to gather information about tree types. Analysis of the message content showed that the concept mapping exercise encouraged spontaneous participation and communication between students both in the field and the classroom. It was also an enjoyable experience for students, who found it easy to add new concepts and their relations. In a similar way, Markett, Sanchez, Webber and Tangney (2006) used SMS to encourage interactivity in the classroom, to facilitate building learning communities and for providing feedback for lecturers. Evaluation data showed a high level of student satisfaction with the experience of using SMS in this way, with students reporting that when using SMS they asked more questions and raised issues that normally would not have been raised during a lecture.

To date, then, researchers have demonstrated that through the simple technology of SMS, embedding information in rich and elaborate contexts can improve foreign-language learning in students above traditional paper and pen rehearsal methods. SMS has also been used to support collaborative learning and encourage interaction, critical thinking and behavioural development with peers and educators as opposed to the traditional passive lecture-style method of delivering

educational content in a process of transmission. Mobile devices generally can be used to allow students to interact with an environment outside of their classroom and collaborate at any point in time (Librero, Juan Ramos, Ranga, Trinona, & Lambert, 2007). SMS is a cheap, convenient, accessible and almost ubiquitous mobile technology that offers great potential as an educational tool that has yet to be fully embraced.

The pilot study conducted at Victoria University, Melbourne, Australia and reported here was informed by the research findings summarised above regarding the use of SMS to enhance student learning. SMS was used to send 14 students studying research design and statistical analysis short quiz questions on research design and statistical analysis that assessed their understanding of concepts covered in class. By sending students messages across the week, it was hoped that they would be motivated to engage with the subject material outside of class. The provision of feedback via a return SMS was included in the study so that students knew whether they had the correct answer or not. An explanation and directions on where to get further information — for example which lecture or part of the text this question was drawn from — were also provided in the feedback. It was hoped that students who did not get the question right would review the relevant material to address any gaps in their understanding.

One of the reasons for using SMS outside of the designated teaching space is that once students leave the classroom, many do not think about the subject material again until the next class, unless they have an assignment or some other assessable learning activity to complete. It was hoped that the short quiz questions delivered directly to the students via their mobile phones would encourage them to review concepts from class and to perhaps spend more time on this subject than they would have otherwise. Unlike a traditional online learning management system (LMS) where students need to be relied on to log into the system to access material, SMS allows the material to be delivered to the student at any time regardless of where they are and whether they like it or not! The bite-sized nature of material sent via SMS also makes it more likely that students will spend a few minutes engaging with a question or problem, as opposed to needing a larger amount of time to deal with a more complex learning activity.

Since many factors contribute to student learning behaviour, we also measured the learning preferences and attitudes to computers of participants in the study. It was hoped that these additional measures would provide insight into factors influencing how students use and respond to this type of learning. Since the pilot study was exploratory in nature, no fixed hypotheses were developed for testing. However, we were interested in measuring students' reaction to using SMS in this way, as well as gaining insight into how this technology could be used to support their learning. In particular, at the end of the pilot we wanted to be able to

determine whether students found using SMS in this way to be convenient and helpful and to understand what impact it might have on their learning.

A Pilot Study Using SMS to Support Teaching Research Design and Statistics

A total of 14 second-year psychology students took part in the SMS pilot study; 6 males and 8 females with an average age of 20.1 years (SD = 1.2). The total enrolment for the unit was 28 students, so the trial participants represented half the students taking the course. Participants were recruited during one of their normal classes. The third author, who also co-ordinates the subject, introduced the researchers and briefly explained the nature of the pilot study. One of the researchers then gave a brief presentation to students on the study explaining that participation in the study would involve completing a questionnaire before and after the study as well as responding to text messages sent to them daily with questions relating to their studies in this subject. Students were told how many text messages would be sent and how often, and the researcher explained the voluntary nature of the study and that privacy and confidentiality of students' contact numbers and responses would be maintained. It was also explained to students that they would be compensated for the cost of text messages sent during the trial with coffee vouchers redeemable at the university coffee shops. Those students who indicated interest in being part of the pilot were given a consent form to sign and provided a mobile phone number for use during the study. They also completed a questionnaire that included items relating to demographic information and data on mobile phone use, together with the measures of their attitudes to computers (CAS, Computer Attitude Scale; Loyd & Gressard, 1984) and their preferred learning approaches (Approaches & Study Skills Inventory for Students, ASSIST, http://www.etl.tla.ed.ac.uk/questionnaires/ASSIST.pdf).

The CAS (Loyd & Gressard, 1984) consists of four subscales measuring how much the respondent likes working with computers (Liking), how useful they perceive computers to be (Usefulness), how confident they are working with computers (Confidence) and how anxious using computers makes them (Anxiety). Each subscale consists of 10 items, scored using a 5-point scale where 1 = strongly disagree and 5 = strongly agree. Higher scale scores indicate a more positive attitude to using computers. This measure was included to provide an indication of the participants' attitude to technology and to see whether students' attitudes to using computers were related to SMS use. The ASSIST was included as a measure of preferences regarding learning. It consists of subscales measuring the extent to which students adopt a deep, strategic or surface approach to study, as well as preference for different types of teaching methods. Items for each subscale are

scored using a 5-point scale, with higher scores on each subscale indicating a stronger preference for a study approach or teaching method.

Mobile phone numbers for those students who completed the first questionnaire in class were entered into a group contact list in a desktop SMS application that was used to send messages during the period the pilot study was conducted. The first text message sent to students was designed to check that students understood how to respond via SMS and asked them to rate their confidence with statistical analysis and design, where 1 = very low, 2 = low, 3 = medium, 4 = high and 5 = very high. After this initial message was sent and the researchers had confirmed that students understood how to respond to the text messages, the phase of the pilot during which questions about research design and analysis were sent out began. A total of 18 SMS were sent to students participating in the pilot over a three-week period either in the morning, after lunch or in the late afternoon. Students who sent a text message in response to messages sent to them as part of the study received a reply text message with feedback on their response, which for the SMS with questions related to their study included the correct answer, an explanation and where to get further help. The questions, which were developed in consultation with the subject coordinator, mapped to material that had been taught in previous lessons. Questions required either a fixed response (e.g., True/False or multiple choice) or a free text response. Examples of questions sent to students include:

> How many separate samples would be needed for a two-factor, independent measures study with 2 levels of factor A and 3 levels of factor B? a)2, b)3, c)5, d) 6?
>
> If decreases in the X variable are accompanied by decreases in the Y variable, then the correlation between X and Y is positive. TRUE OR FALSE?
>
> You are asked to evaluate 3 weight loss groups (1)No carbs (2)No protein (3)No fat. 10 volunteers are randomly placed in each group. What design would you use?

At the end of the pilot, the last SMS sent to students asked them to again rate their confidence with statistical analysis and design at the end of the pilot study. In the last class for the semester, students were asked to complete the evaluation for the study and to return these to the subject coordinator. Students were followed up via SMS to encourage all participants to complete and return the post-trial evaluations. Unfortunately, 5 of the participants did not return the post-trial evaluation. Coffee vouchers were distributed to the study participants at the same class that the evaluation was given out. The evaluation instrument included questions about

when students preferred receiving text messages, how soon after receiving a message they responded to it, and whether the message was intrusive, convenient to receive in text format or important. There were also 16 statements relating to the use of SMS for teaching and learning purposes which they were asked to rate using the scale 1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree nor Disagree, 4 = Agree and 5 = Strongly Agree.

The message content of student responses for each question sent via SMS was exported as a text file from the desktop SMS application and matched to the data from the pre-pilot questionnaire and the post-pilot evaluation. All the data was then imported into (Statistical Package for the Social Sciences) SPSS for scoring and analysis.

Findings from the Pilot Study

Preliminary data analysis consisted of evaluating the responses to SMS questions as incorrect or correct and calculating scores for each of the measures of attitudes to computers and preferred learning and teaching approaches. Descriptive statistics, including means, standard deviations and correlations were obtained for all variables of interest.

Attitudes to Computers and Preferred Learning Approaches

Scores for the subscales on the CAS (Loyd & Gressard, 1984) showed that as a group, these students were moderately confident using computers ($\underline{X}$ = 35.39, $\underline{SD}$ = 4.23, $\underline{N}$ = 14) and tended to agree that they liked using computers ($\underline{X}$ = 36.5, $\underline{SD}$ = 6.28, $\underline{N}$ = 14). However, they were not anxious using computers ($\underline{X}$ = 41.57, $\underline{SD}$ = 6.16, $\underline{N}$ = 14) and agreed that computers were useful ($\underline{X}$ = 43.21, $\underline{SD}$ = 3.26, $\underline{N}$ = 14). This suggests that the students who participated in this pilot were comfortable using technology such as computers, but were not necessarily technology evangelists.

Scores on the subscales for the ASSIST were computed for the deep, strategic and surface approaches to learning, as well as preference for different types of teaching methods. The average scale score for the deep approach to learning subscale, which consists of 16 items was $\underline{X}$ = 59.6 ($\underline{SD}$ = 8.4, $\underline{N}$ = 13). For the 20-item subscale measuring a strategic approach to learning the mean scale score was 69.5 ($\underline{SD}$ = 15.2, $\underline{N}$ = 13), while for the 16-item subscale measuring a surface approach to learning the mean score was 48.4 ($\underline{SD}$ = 8.3, $\underline{N}$ = 13). This pattern of scores indicates that the participants agree that they tend to be strategic and adopt a deep approach to their study, but are undecided as to whether they prefer a surface approach to their learning or not. For the two subscales measuring preferences for different types of teaching methods, the mean score for the 4-item subscale

measuring a preference for a teaching style that supports understanding was 15.4 (SD = 2.9, N = 13). For the subscale measuring a preference for a teaching style that supports transmission of information, which also has four items, the mean score was 16.9 (SD = 4.1, N = 13). This pattern of scores shows that the students who participated in this pilot showed a strong preference for teaching styles that promoted understanding, while at the same time wanting the lecturer to tell them what they need to know for the course, what to study and how to study it.

The post-pilot evaluation was completed by nine participants who evaluated the experience positively as indicated by their responses to the statements about using SMS. As a group they agreed that "receiving information relating to their studies via SMS is a good idea", that they "would like to receive important information from the university via SMS", and that they didn't mind receiving text messages from their lecturers provided they are relevant. However, they also tended to agree that they would feel uncomfortable if they started receiving SMS about their studies, but disagreed that they would prefer to keep their mobile phone for personal purposes. Several items on the post-trial evaluation asked about the comparative value of SMS over e-mail as a medium of communication. In general, these students did not have a problem with receiving information in more than one format (e.g., via SMS and e-mail) and disagreed that receiving information via SMS is more convenient than receiving it via e-mail. Consistent with this, they tended to disagree that they would rather receive information via one method only. Finally, they tended to disagree that receiving a text message more than once a week for a unit they were studying would be annoying. These nine students also reported that they preferred to receive text messages of this nature in the morning or the afternoon and the majority of them read the text message either immediately or within an hour of it being received. They did not find the messages intrusive, and rated receiving the questions this way as convenient. They also felt that the content of these messages was important to them. In response to the question about how much they would be prepared to spend on using SMS in this way for a subject, these students indicated that between AU$1 and AU$5 per subject per semester would be the maximum.

Analysis of Text Messages

The average number of text messages students responded to was 10.6 (3.6) with the maximum number of messages replied to being 14, and the least being 3. Five students replied to 14 messages, while only 1 replied to only 3. For the messages students responded to, on average they answered 59.3% (SD = 25.1) correctly. The average level of confidence at the start of the study was 3.5 (SD = .86, N = 14), while at the end it was slightly, but not significantly, lower at 3.4 (SD = .71, N = 9). These mean scores indicate that students had a moderate level of confidence relating to research design and statistics at the start of the study which was maintained across time.

No significant correlation was found between the total number of replies a student submitted and any of the approaches to learning scales or the attitudes to computers scales. Total number of replies made was however, significantly and negatively correlated with scores on the computer attitude scale of Liking ($r = -.60$, $p < .05$, $r^2 = .36$ $N = 14$), suggesting that students who do not like using computers will send fewer text responses than those who do like using them. There was no significant correlation between exam scores for the unit and the number of responses students made. Exam performance was also not correlated with the number of questions responded to. However, a significant correlation was found between exam grade and the percentage of correct answers submitted (adjusting for the total number of responses a student made) $r = .749$, $p = .002$, $r^2 = .56$ $N = 14$. Since no causality can be inferred from this significant correlation, it would be interesting to investigate this relationship further. In particular, it would be helpful to know if the regular knowledge checks delivered via SMS assisted students in identifying areas of strength and weakness in their understanding of the material, which they were then able to use as part of their exam preparation. Overall, students perceived participation in the pilot study as a positive experience, with over three quarters of respondents indicating that receiving the text messages had contributed "quite a bit" to their learning experience for the unit.

To gain some insight into the possible impact of this SMS intervention on student learning, a t-test for independent samples was conducted comparing exam scores for the students who took part in the study with those who did not. This analysis showed a significant difference between scores on the final exam in the subject for students who participated in the trial and those who did not ($t(26) = 2.624$, $p < .05$, $r^2 = .21$). On average, participants in the pilot study scored significantly higher ($X = 43.2$, $SD = 11.8$) compared to those students who did not ($X = 33.1$, $SD = 8.1$). However, the reason for this superior performance cannot be unequivocally attributed to the effects of participating in the study. It may be that the students who elected to participate in the pilot were academically stronger, or more motivated to achieve, than those who did not. However, it could also be that taking part in the study highlighted to students that they did not know the material as well as they thought they did (as indicated by the relatively low number of correct responses submitted) and this may have encouraged them to study more for this subject than they would have normally. Feedback on each of the questions sent via SMS could also have helped students to focus their study efforts on topics where they did not get the questions correct.

Future Directions and Challenges for Mobile Learning Technologies

Due to the exploratory nature of this pilot study, no hypotheses were formulated for testing. However, it was intended that data collected for the pilot study would be used to determine whether students found using SMS in this way to be beneficial and acceptable. We also wanted to gain some insight into what impact it had, if any, on their learning. From the analysis of the text message content and the data from the pre-pilot questionnaire and post-pilot evaluation, we have been able to confirm that students did respond positively to the experience and also have some data that points to a positive impact on student learning. From the analysis of the pilot data, it has also been possible to identify future research directions that will add to our understanding of how to use this technology effectively to improve student learning.

Consistent with previous research, students' generally perceived the experience of receiving and responding to questions about research design and statistical analysis via text messages positively. A negative relationship was found between number of replies sent and scores on the computer liking scale, which may explain the low number of responses some students sent. Even if this did contribute to response rate, however, it does not necessarily mean that receiving the questions via SMS was not useful for students who do not like using computers, only that they are likely to reply to fewer messages. This could be for a number of reasons, including time and cost. Not responding to a question does not rule out the student actively learning from the question in the text message, as they could still answer the question without sending a response. The problem with not sending a response is that the explanation and instructions about where to get additional help for the question are only sent when a response is received. Therefore students who do not reply miss out on potentially beneficial information.

The data collected for this pilot does not provide any insight into what students did when they received an SMS, other than some indication that they responded to it either immediately or within an hour of receiving it. The high percentage of incorrect responses suggests that students did not consult any notes or their text book before responding. This in turn suggests that students were either confident their answer was correct, or it didn't bother them if they got the answer wrong. Although it was hoped that students would take the time to consult other sources such as their notes, textbook or other classmates, before responding, this did not seem to happen. In future studies using SMS in this way, it would be valuable to obtain data on what students do when they receive a message. This could be collected using an observational technique or through interviews where students report on what they typically do in this situation. A research design could also be employed where students study some topics with SMS quizzes and some without.

In this way it will be possible to directly compare each student's performance on the different topics and better assess the impact of the SMS quizzes on student learning outcomes, assuming topics studies with without SMS are of equal difficulty.

Another aspect we did not directly observe or measure is whether students consulted or collaborated on the answers to the questions. While collaboration is to be encouraged, merely copying another student's answer and submitting it should be strongly discouraged. To try and avoid students waiting to find out the correct answer before responding, we did not send instant feedback to students on each question. Rather, feedback was only sent after students had sufficient time to submit their response. In this way we tried to encourage students to work out the answer for themselves rather than waiting to find out the correct answer and then submitting a response. As this technology is used in different contexts, teachers will develop strategies for managing some of the student behaviours and strategies that are not helpful to their learning.

Participants in the study had a moderate level of confidence in their understanding of research design and statistical analysis. This level of confidence was maintained across the period of the pilot study. It is reassuring that students' confidence did not decrease, which could have occurred if students were concerned about getting the questions wrong, which they did quite frequently. However, it is also not possible to make comparisons with the confidence level of students in the class who did not take part in the pilot and we have no way of knowing what their confidence was at the start and whether it stayed constant, increased or decreased. We do know that those students who took part in the pilot study did significantly better on the final exam than those who did not, despite not performing consistently well on the SMS questions. Given this, it is not unreasonable to assume that taking part in the pilot and getting feedback that you do not know the correct answer to a problem that is likely to be on the exam could be quite motivational. Through their participation in the pilot study, students may have been made more aware of their lack of knowledge and studied more to make up for this. They may also have been able to focus their study efforts better by receiving feedback on which questions they got right and which ones they did not.

An interesting finding was that students in the pilot all favoured teaching approaches that used transmission of information as well as supporting understanding. Students who favour a transmission of information approach would likely find the use of SMS in this way appealing as it gives a very good indication of what content the lecturer sees as important. It also provides an example of how this content can be assessed. Equally, for the student who favours a teaching approach that supports understanding, this application would be appealing as it provides another source of information that can be used to assess whether a

student understands the material or not. Students in this study scored high on both the transmission of information and supporting understanding approaches. It would be valuable to explore this further in future studies to determine whether use of SMS to support learning is dependent on favouring a transmission of information or supporting understanding approach to teaching, or both.

While using SMS in this way had benefits for students, it also offers opportunities for teachers. As the pilot study progressed it became clear that greater use could be made of the analysis of student responses to the SMS quiz questions. In particular, the number of correct responses received provides the lecturer with an indication of whether students understand the concepts being tested. If sufficient numbers of students get a question wrong, then the lecturer can use this information to address this in class. Although the findings from this pilot are very positive, they need to be interpreted with care due to the small sample size. SMS used to support students studying research design and statistical analysis was successful as a pilot, but needs a larger scale implementation and evaluation. Future studies should also incorporate research designs and data collection methods that allow evidence to be obtained about the learning outcomes associated with using SMS in this way. For teachers to be confident using this technology to support student learning, it is necessary to move beyond subjective evaluations of the learning experience by the participants, to gathering hard data on the impact on student learning. However, mobile learning technologies in general, and SMS specifically, appear to have great potential of improving student learning outcomes. The possible applications need to be explored and validated so that both teachers and students can realize the benefits of these approaches.

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