“Pls Turn UR Mobile On”: Short Message Service (SMS) Supporting Interactivity in the Classroom

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree in this or any other university.

Signed: _____

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1 September 2004

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Carina Markett

1 September 2004

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Abstract

Classrooms are currently awash with under-utilised technology; one challenge for educators is to harness this available technology while building a pedagogically sound learning environment. Short Message Service (SMS) is a popular method for quickly sending concise, text-based messages at any time. Encouraging students to instigate contact via the low-threshold technology of SMS may be a way of supporting interactivity in the classroom.

Various definitions of interactivity exist in the literature, alternately focusing on the participants, structure and technology. Yacci's (2000) definition of interactivity as student-originated message loops connects student-centred pedagogy to communication theory, while allowing for a variety of technology interventions. Examining the challenges facing Information Communication Technology (ICT) implementation in education, key concerns arise: technology is in the foreground, pedagogy is neglected, costs remain high and student-to-computer ratios remain low. Current research suggests that using wireless, handheld devices or ubiquitous technology can overcome such concerns (Hoppe, Joiner, Milrad, & Sharples, 2003; Roschelle & Pea, 2002).

The premise of this project is as follows: students use their personal mobile phones during class to send SMS in real-time. Using the project's artefact - a modem interfacing with customised software to produce text and spreadsheet files of SMS – the lecturer can view the messages. The lecturer can develop the interactive loop with students during class, by verbally addressing the SMS content. Using a php / MySQL interface, the SMS are available after class; and the student-lecturer and student-student interactive loop develops online via threaded comments.

The project implementation occurred in two university computer science classrooms during lectures and group presentations. Evaluation of the project is approached on multiple levels to assess SMS as an interactive classroom tool. Interviews and questionnaires with both students and the lecturers explore perspectives on interactivity and the use of the artefact in class and after class. Further data is gathered from the researcher's observations, sent SMS and website postings.

The findings of this project suggest that both students and lecturers are interested in using SMS in the classroom to open additional channels of communication and maintain awareness of the interactive loop. However, there are concerns regarding cost and distraction that require new iterations in both project design and implementation. 4 now, keeping students' mobiles switched on may B grt 4 ed!

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Section 1: Introduction

The benefits of interactivity in the classroom are well documented; it promotes a more active learning environment, builds a learning community, provides greater feedback for lecturers, and helps student motivation (Anderson, 2002; Muirhead & Juwah, 2003). However, determining whether a class is interactive is a difficult exercise in perspective. Lecturers may view their class as interactive because they ask questions or accept questions, but they frequently fail to examine the quality, content, frequency or duration of the interactions, in addition to whether the *majority* of students participate.

ICT has played a significant role in supporting interactivity both in class and after class via interfaces such as email, chat, bulletin boards and Classroom Response Systems. Students can initiate interactivity in class using this project's interface. Through a structured framework, involving in-class and after-class interfaces, students and lecturers are introduced to the idea of a loop of interactivity (Yacci, 2000). This loop can be viewed, amended and closed using the course website.

In many classrooms, the beeps and rings of mobile phones are a continuous nuisance, distracting the attention of students and lecturers. Mobile phones are the technology closest to hand, always in the pocket and always on the go. Students are probably texting and talking in class when they shouldn't be. Is it time to *encourage* texting and talking in class?

In this project, technology is used to support the interactive loop for students and lecturers, providing opportunities to view and edit data both in class and after class. To capture and display the SMS in class, the researcher modified existing software. The SMS are parsed through a modem and software into text and Excel files. The lecturer can then display or introduce the SMS to the full class. Following class, all SMS messages are uploaded to a web-based database, which provides data fields for

the capture of amendments and comments. The class website, using php coding, is the after-class interface for data display and editing.

The project implementation is a case study within two university classes. Class A is an undergraduate computer science lecture where students had three one-hour meetings using the ICT-enhanced interface. The Class B implementation occurred during six student presentations, over 2 two-hour meetings, within a post-graduate ubiquitous computing course. The data collection methods in both classes include direct observation, pre- and post-project questionnaires, interviews, and SMS and website data capture.

This project's findings show varied use of the SMS function within the two classes: 32% for Class A and 65% for Class B. This compares favourably with data gathered on non-ICT-based interaction in these classes. Of the 61% in Class B who completed the post-project questionnaire, 64% were interested in using the technology again. Both lecturers would use SMS in some of their future classes. While many suggestions were made about possible improvements to the design and implementation, the assertion can be made that texting in class works.

Dissertation Roadmap

The written component of this dissertation consists of five sections. Section 1, Introduction, sets the background for the research project and provides a roadmap to the dissertation.

Section 2 is the Literature Review, focusing on three areas of literature: interactivity, ICT in the classroom and mobile phones. Interactivity in the classroom is examined holistically, including definitions, evaluations and mitigating factors. ICT in the classroom is examined in the context of cost, logistical considerations and factors in successful implementations. Given the limited use of SMS in education, it is necessary to ground this project via an understanding of the student and institutional attitudes towards mobiles and SMS.

Section 3 is Design, where the key design feature (the interactive message loop) is developed and diagrammed. The function of students and the lecturer in the interactive loop, in class and after class, is vital to the design with the initiator of the message (the student) taking a central position. Also discussed in relation to design are the practical benefits of SMS, i.e. low cost, mobility, record of messages and known interface. Finally, this section concludes with the technical elements of design, including selection of the ICT interface to capture and display SMS and development of class website.

Section 4 is the Methodology and Evaluation, which begins with a discussion of the case study research approach followed by an examination of the implementation stages. The first stage in implementation is the selection of the classes involved, project logistics and completion of pre-project questionnaires. The second stage includes project work both in class and after class, including limited modifications to the project design. Finally, student post-project questionnaires and lecturer interviews were completed.

Section 5, Findings and Conclusions, involves the analysis and correlation of the multiple data collected. Suggestions for future developments, in design and implementation, are explored in this section. In addition, the findings of this research project are discussed in relation to the larger research fields of interactivity, ICT and mobility.

Section 2: Literature Review

Introduction

This project examines using the SMS function on students' mobile phones to support text-based interaction during lectures. The project development focuses on three sections of literature: interactivity, ICT in the classroom and mobile phones.

A key aim in examining the literature on interactivity is to determine what defines interactivity within an educational setting and how interactivity can be evaluated and measured. In approaching the project, the researcher held practice-based views on interactivity, specifically in relation to the student perspective. However, to develop a project that supports interactivity requires a more holistic view of interactivity in the classroom.

Similarly, research on ICT in the classroom indicates that ICT implementations must take into account the pre-existing classroom environment and pedagogy in addition to issues regarding cost and usability. The examination of ICT in the classroom focuses not only on cost and logistical considerations, but also on factors in successful implementations.

Finally, this section finishes with a discussion of the benefits and disadvantages of using mobile phones, and specifically SMS, in educational research. With limited use of SMS in education, an understanding of the student and institutional attitudes towards mobiles and SMS is essential to ground this research.

Defining Interactivity from the Literature

There is some confusion surrounding various terminologies in educational research and practice. In particular, researchers and practitioners often refer to interactivity as a beneficial educational practice without defining what is meant by interactivity (Moore, 1989). A review of the literature on interactivity, referring to face-to-face and distance learning, shows multiple definitions.

One definition is based on the participants of the interaction. Moore (1989) focuses on three key interactions: learner-content, learner-instructor, and learner-learner. In Moore's definition, learner-content interaction is central, with learner-instructor and learner-learner interactions strengthening and progressing the learner's engagement with and understanding of the course material. Referring to participants in the interaction, learner-interface, instructor-interface, instructor-content, instructor-instructor and content-content are additional types of interaction (Muirhead & Juwah, 2003). However, the focus on learner-content is prevalent (Anderson, 2002), and as far back as 1916, Dewey defined interaction in relation to learners transforming information and constructing knowledge (Dewey, 1916). Given May's (1993) assertion that some learners actively avoid classes which require learner-instructor and/or learner-learner interaction, the continuing centrality of the learner-content interaction is understandable.

A divergent way of defining interactivity focuses on the structure – ideas regarding loops, coherence and originator. Yacci (2000) defines interactivity as a message loop that starts and concludes with the student where the content of the messages must be 'mutually coherent'. Wagner (1994) also defines interactivity by structure – a loop of 'reciprocal events'.

The above definitions of interactivity do not explicitly reference technology, and are developed from communication and educational theories. In contrast, many educational technologists define interactivity by the medium of communication. Liu, Wang, Liang, Chan and Yang (2002) classify four types of interaction, with *face-to-face* being the traditional classroom-based interaction where students' seats are directed towards the lecturer and lecture materials. *Computer-mediated* interaction can occur in any physical space or time and frequently supports student-student activities. *Human-computer* interaction is categorised by a computer program providing individual, customised instruction. The fourth interaction as posited by Liu, *et al.* is the use of personal devices to support *simultaneous group* interaction, i.e. student communication mediated by the lecturer and technology.

Bringing together the above definitions and categorisations of interactivity, interactivity can be described as a complete message loop originating from the student and returning to the student. The reciprocating participant can be instructor or fellow student(s). This loop occurs irrespective of the technology or medium of communication.

Benefits of Interaction

Numerous researchers have explored the benefits of interactivity. Through interaction with the instructor and other students, the student's interest and motivation can be stimulated and maintained (Prammanee, 2003). A key strength of student-instructor interaction is that it puts the concepts which students develop from the content into context, allowing students' development of cognitive structures (Liu *et al.*, 2002; Moore, 1989). Interactivity can also allow students to build their learning environment and influence the learning process, leading to more active learning while providing instructors with ongoing feedback (Anderson, 2002; Muirhead & Juwah, 2003). Specifically within the distance-learning field, where much of the research on interactivity is occurring, interactivity has been shown to reduce student isolation, positively affecting performance and enrolment (Hirumi, 2002). This can be particularly true of student-student interactions, which provide a valuable support mechanism for distance learners (Fahy, 2003).

Factors in Interaction

Some of the factors that affect interaction levels include the message complexity, lecturer approachability, possibility of simultaneous interaction and class duration. Since the message medium plays a role within these factors, comparisons are drawn between face-to-face and text-based interactions.

A traditional face-to-face lecture allows for complex levels of expression – with non-verbal cues (nods / smiles) and paralanguage (tone / speed of voice) expressing emotion (Garrison, Anderson, & Archer, 2000). In computer-mediated text-based interactions, emoticons (☺) allow for transmission of emotions (Hirumi, 2002; Liu *et*

al., 2002; Yacci, 2000), but not with the same ease of interpretation and frequency as in oral communication (Prammanee, 2003).

With regard to opportunities for interaction, spontaneity and student interruption are frequent in face-to-face classes. However there is an aural limit to comprehendible interruptions and some students are averse to interrupting their peers or lecturer (Liu *et al.*, 2002). Text-based interactions may provide greater flexibility in relation to this. Depending on the technology, participation may vary from a situation where "all students can answer all questions, instantly" (Davis, 2003, p. 304) to one where if limits are not put in place the instructor may be unable to facilitate effectively (Yacci, 2000). While queuing of hand-raising can occur in both face-to-face and text-based environments, preventing students from following live classroom issues while they prepare their question / comment, technology can be designed to overcome this issue (Muhlhauser & Trompler, 2002).

Opportunities for interaction in face-to-face classes frequently end at the lecture's scheduled conclusion time, with only 19% of students asking lecturers questions after class (Oblinger, 1995 c.f. McFadden, Marsh, & Price, 1999), while most computer-mediated systems encourage greater contact and clarification after hours (Liu *et al.*, 2002; Prammanee, 2003).

Evaluating Interaction

Research that evaluates levels of interactivity has been limited. Studying face-to-face interactions, Fulford and Zhang (1993) found that students' perceptions of interactivity levels do not correlate with actual interaction time. Yacci and Hyman (2001) assert that the level of paralanguage and the message content can affect student assessment of interaction more than affective cues.

Defining interaction as a loop originating from the student places the student at the centre of measuring interactivity and brings into play questions of acknowledgement and reciprocity. Yacci observes:

> If we look at interactivity from the student perspective, we realize that many alleged interactive lessons and devices are not interactive at all. For example, a teacher may ask a student for a response, and receive the response from the student but fail to provide feedback, thus failing to complete the student's interactive loop. From the student perspective the student response is sent "into the vapour" with no sense of transmission received, transmission accepted, transmission understood, or transmission lost. (Yacci, 2000, p.4)

The opportunities for messages to be lost 'into the vapour' are fewer with face-to-face classroom interactions: lecturers receive and accept messages immediately, they are not lost. However, in computer-mediated text-based interactions, the sense of transmission can be weaker: in-boxes receive and accept messages immediately, but the lecturer may not – and students could experience a considerable time lapse for receipt and acceptance while not knowing if the message is received. Measuring transmission understood is more difficult for all learning environments, since the content of the response demonstrates whether the transmission is understood. When the two messages in the interaction loop have related content, mutual coherence (on a varying scale) occurs (Yacci, 2000).

Challenges, Future Research and Conclusions

There are many challenges facing educators who wish to enhance the opportunities for interactivity in the classroom or the quality of the interactivity. First, one must define interactivity. Second, one must accept that interactions occur as part of the overall class activities; they are only a component of the instruction. Gay, Stefanone, Grace-Martin and Hembrooke write: "the benefits…can easily be lost if that complexity is not appreciated and understood" (2001, p. 273). Building interactions into the course or lesson structure is one solution for affecting meaningful interactions (Hirumi, 2002). Finally, the multiplicity of different interactions enhances the overall interaction; as for example, student-instructor and student-student interactions support student-content interaction (Moore, 1989).

ICT in the Classroom

ICT is used in a variety of ways as an interaction tool in the classroom and in distance learning. However, the role of computers in educational environments is frequently limited by financial constraints. With desktop computers, the average ratio of student-to-computer is five-to-one, with many schools locating computers in a special

lab (Roschelle & Pea, 2002). This 'imprisonment' of ICT in the lab is far from the one-to-one ratio that many educational technologists advocate and can prevent integrating ICT into the full curriculum (Cereijo-Roibas & Arnedillo-Sanchez, 2002).

One solution to achieve a better student-to-computer ratio and more frequent, integral use within financial constraints is to invest in less expensive handheld technology such as palm devices, graphing calculators or mobile phones (Roschelle & Pea, 2002; Savill-Smith & Kent, 2003).

Handhelds, with their 'unobtrusive usability' (Nyiri, 2003) affording *anytime, anywhere* connectivity typify ubiquitous technology (Savill-Smith & Kent, 2003). Weiser and Brown at Xerox PARC identified ubiquitous computing as when computers "become so commonplace, so unremarkable, that we forget their huge impact on everyday life" in the same way that the technology of writing and electricity are ubiquitous (1996). In regards to pedagogy, ubiquitous computing offers the opportunity to send technology to the background; as handhelds do not physically dominate the classroom, they can allow greater focus on the learning activity and classroom interaction (Hoppe *et al.*, 2003). Ubiquitous technology in the classroom can allow for the use of applications where "the human is in the loop" (Milrad, 2003, p. 161).

The personal nature of handhelds, their location *in the pocket/to hand* leads to the idea that the information obtained on such devices may readily secure the user's attention and be more personally authentic (Cereijo-Roibas & Arnedillo-Sanchez, 2002) without greatly distracting the user's attention (Pinkwart, Hoppe, Milrad, & Perez, 2003). In parallel, when users have a sense of control over software (i.e. a familiar handheld interface), the trust in the system is increased along with its software's utility (Stone, 2002).

Handheld Challenges

Using mobile handhelds in the classroom blurs the lines between formal and informal learning arenas; creating a bridge between the two that Mifsud (2002) refers to as 'alternative learning arena'. Expanding where and when learning occurs can "transform learning as a pleasurable, constructive, everyday experience" (Strohecker & Ananny, 2003). Within educational environments where students frequently move venues, using students' personal devices for learning appears natural (Muhlhauser & Trompler, 2002), although issues can arise over device ownership and control (Savill-Smith & Kent, 2003; Stone, 2002). Students must support the co-opting of their personal devices and educators must overcome attitudes such as one university student's assertion that "the mobile phone is mine. It has nothing to do with the school." (Divitini, Haugalokken, & Norevik, 2002, p. 5).

Allowing the use of primarily social technology such as instant messaging or mobile phones can focus student attention away from the classroom (Roschelle, 2003), acting as an 'intruder' and removing the teacher's centrality in communication (Mifsud, 2002). Mobile phones are banned in many schools, prompting one research study to use simulated mobile phones on PDAs (Bollen, Eimler, & Hoppe, 2004). A recent study found most implementations of handhelds do not involve connectivity outside the classroom or the ability for students to pass notes via a back-channel (Roschelle, 2003).

If the school provides handhelds, policies regarding proper use (game downloading / pornography) and care (theft / accidental damage) are essential for a safe and lasting implementation (Roschelle, 2003; Savill-Smith & Kent, 2003). If the school relies on students' personal devices, issues and tensions can arise if not all students are similarly equipped and able to access the full communication systems (Iles, Glaser, Kam, & Canny, 2002).

Classroom / Personal Response Systems

One of the most widespread models for implementing handhelds into the classroom is a Classroom / Personal Response System where teachers ask short answer or multiple

choice questions and students respond via remote devices. The teacher facilitates all messages, displaying the responses in a histogram, and replying to the messages en masse during class. Research indicates that classrooms using this model are more learner-, assessment-, knowledge- and community-centred (Roschelle, 2003).

One aspect of Classroom / Personal Response Systems that students appear to appreciate is the public anonymity (the teacher knows who sent what, but other students do not); this encourages shy, non-participatory or self-conscious students. All students are valid contributors to the ensuing discussion – whether they supply right or wrong answers (Davis, 2003). Anonymity can prompt increased learner-content interaction, with one student noting, "how nice to actually be asked to think in a lecture" (Draper & Brown, 2004, p. 89). Incorporating all responses in the learning promotes classroom accountability and encourages student interaction (Davis, 2003; Woods & Chiu, 2002).

For students, the public display of responses allows them to privately know 'where they stand' and the ensuing discussion provides valued feedback. For teachers, the responses are the feedback, allowing them to immediately know, generally and in relation to specific students, which concepts were understood, controversial or need to be re-taught (Davis, 2003; Woods & Chiu, 2002). This supports contingent teaching, whereby the content and approach varies according to student actions (Draper & Brown, 2004).

Although versions of Classroom / Personal Response Systems have been used widely for decades, limitations and challenges remain. The increased participation due to system use correspondingly dropped with its removal (Davis, 2003) and questions are limited to multiple-choice format (Woods & Chiu, 2002).

Effective ICT Implementations

When implementing ICT in the classroom, it is essential to take into account the pre-existing classroom environment including the individual teacher's methods. New ICT

does not necessarily alter the daily activity and may be designed specifically to enhance it. For example, the Classroom Response System supports the same activities that teachers have been doing for decades: asking students questions, collecting and checking homework and verifying student comprehension of taught concepts (Davis, 2003). In increasing interaction mediums, new ICT must avoid communication and information overload (Iles *et al.*, 2002) and distracting interfaces. Sustainable implementation of ICT, what Muhlhauser and Trompler call smooth, should avoid big technology leaps and high-support laboratory set-ups. Offering a step-wise implementation and a low-technology-threshold for teachers, their digital lecture hall requires as little *imposed* change for students and teachers as possible (Muhlhauser & Trompler, 2002). Students have criticised implementations when technology is being used for its own sake, superseding pedagogy (Draper & Brown, 2004).

ICT Network Scenarios

There are several scenarios for networking ICT in a classroom; one key difference is whether the ICT devices (desktops, laptops, handhelds) come with 'plug and play' networking capabilities or whether a network needs to be installed as a component of the ICT implementation. The table below lists various network scenarios and their benefits and disadvantages.

Network Scenario	Network Capability	Benefits	Disadvantages
Hard-Wired	Installed Separately	Tried & tested	Stationary
Wireless	Installed Separately	Student & teacher mobility	Commercial withdrawal of applications / devices
Infrared	Plug & Play Devices	No infrastructure or maintenance required	Whole class activities not supported; limited coverage
Mobile Phone	Plug & Play Devices	No infrastructure or maintenance required; wide coverage	Costed per use; cost set by external commercial forces; overall high cost
Bluetooth	Plug & Play Devices	No infrastructure or maintenance required; wide coverage	Bluetooth devices not as widespread as others

Table 2-1 ICT Network Scenarios
(Sources: Mitchell, Heppel, & Kadirire, 2002; Pinkwart *et al.*, 2003; Roschelle, 2003; Savill-Smith & Kent, 2003; Woods & Chiu, 2002)

When a hard-wired or wireless network needs to be installed as a separate component of the ICT implementation, there are higher costs involved in both ICT set-up and maintenance, while reliability and cost of hardware / applications are important variables. However, the non-networked solutions are limited either by distance (infrared), cost (mobile phone) or availability (Bluetooth). As the above comparison table shows, each networking option has financial and structural benefits and disadvantages; there is no easy choice when selecting a network scenario for ICT in the classroom.

Mobile Phones – Ubiquitous Technology

The mobile phone is one of the most successful new technologies of the past two decades (Clark, 2001; Nyiri, 2003). In Ireland, 91% of 15- to 24-year olds own a mobile phone with rates of text messages and spending among the highest in Europe (Hegarty, 2004). In a Finnish study of university computer science students, 95% owned a mobile (Divitini *et al.*, 2002). In addition to high rates of ownership, users typically have mobiles at hand or in-the-pocket the majority of the time with access rate to mobile phones well beyond the typical work or study day (Cereijo-Roibas & Arnedillo-Sanchez, 2002; Markett, 2003). Although Pinkwart *et al.* advocate that "PDAs appear to be a straightforward solution to mobile applications" (2003, p. 384), their purchase prices are much higher and penetration rates among the student population lower than that of mobile phones (Divitini *et al.*, 2002; Savill-Smith & Kent, 2003).

SMS –The 'Killer' Mobile Phone Application

SMS has been called the 'killer' application of mobile phones, as its usage exceeded all expectations. Some reasons given for the huge growth include low cost, asynchronous nature (users can reflect before sending a reply and reply at their leisure) and potential for private / quiet use (Mitchell *et al.*, 2002). In student populations, 100% of students in one study send and 80% use SMS almost every day (Divitini *et al.*, 2002).

Using mobile phones as an interactive/communication tool in an education setting requires minimal financial and technical support: the majority of students possess the

needed hardware and software (Divitini *et al.*, 2002) and communication occurs via existing mobile networks, which are maintained independently by mobile service providers. Students and teachers do not need technology training as mobile phone applications and interfaces are a known technology, and not intimidating to most users. Current research has capitalised on these technological and practical advantages: developing public discourse in disadvantaged communities (Ananny, Strohecker, & Biddick, In Press), supporting disadvantaged youth with literacy and numeracy skills (Mitchell & Doherty, 2003), and delivering content and promoting discussion with 'bitesized' exam revision (Hoppe *et al.*, 2003). Under Papert's definition, the use of mobile phones / SMS within populations familiar with the technology would be a 'low-threshold, high-ceiling' technology tool (Papert, 1980).

Several researchers have indicated that SMS is an area for further exploration in education: in-class discussions (Bollen *et al.*, 2004), two-way service interactions, creative 'free spaces' for text-based play (Stone, Briggs, & Smith, 2002), and learning support (Mitchell & Doherty, 2003). Preliminary data shows that students interested are in using SMS for after class administration (grades, scheduling, contacting students or lecturers) and in class communication (Divitini *et al.*, 2002).

However, there are some limitations and concerns when designing ICT classroom implementations involving mobile phones. Rapid developments in handsets, networks, and mobile applications can make educational implementations using mobile phones high-risk (Mitchell *et al.*, 2002). Like PDAs, mobile phones have a small screen size and restricted / time-consuming text input functions. Unlike wireless PDAs, within Europe and Asia, mobile phones have *one killer application* – SMS (Mitchell *et al.*, 2002; Roschelle, 2003). Future applications of SMS must recognise the 160-character limit in messages and the cost (Divitini *et al.*, 2002; Lehner & Nosekabel, 2002).

Conclusions

Interactivity in an educational environment has been difficult to define and study in educational research. Defining interactivity from the student's perspective leads the researcher to solutions that assist students and instructors in understanding the idea of a message loop. As the student is the message initiator, the technology used should be known and available to the student. The mobile phone is easily available, low-cost, and pervasive. A pedagogically supported use of Short Message Service (SMS) within classrooms may allow for low-cost implementation of real-time, text-based interactions and put an end to the familiar refrain of "*turn UR mobiles off*!"

Section 3: Design

Introduction

This section begins with discussions and diagrams of the project's interactivity features. Beginning with the instance of student-initiated interactivity (via SMS), the interplay between students and the lecturer is examined. After the structure of the interactions is determined, technical design issues are explored for building the two interactive ICT tools. The section concludes with the selection of the ICT interface to capture and display SMS and the development of the class website.

The key design feature of this research project is the use of ICT to support students and instructors in understanding and using an interactive message loop. The guiding principles of the interactive message loop, as developed in the previous section, are:

- The interactive loop originates and concludes with the student
- Interactivity can occur irrespective of technology: involving technology in all, some or none of the interaction stages
- The originating student 'owns' the interaction, determining if the loop is completed

The above key principles build on communications, ICT and pedagogical theories of interactivity (Liu *et al.*, 2002; Moore, 1989; Yacci, 2000).

The Interactive Message Loop

Yacci (2000) has developed a basic model of interactivity, notable for the loop commencing with and returning to entity 1 (defined as the student):

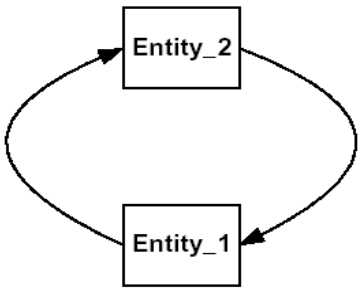


Figure 3.1 A Completed Message Loop Between Two Entities
(Source: Yacci, 2000, p. 3)

As discussed in Section 2, Yacci's definition of interaction does not reference specific ICT interfaces within the interactive loop (2000). Liu *et al.* posit three types of interaction where the technology is central in conveying a message (computer mediated, human-computer and simultaneous group). These interactions, as defined by the authors, crucially do not reference or track the resulting message path (2002).

The following three interactive loop models were developed by the author to reference and track the resulting message path, indicating the function of Student A, the lecturer, the ICT interface and Student B. In all three models, the ICT interface acts as conduit between participants and between the 2 halves of the interactive message loop:

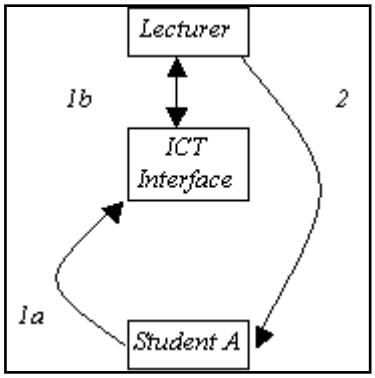


Figure 3.2 Interactive Message Loop 1: Student-Instructor Interaction (in-class)

Figure 3.2 (above) shows that the interactive message loop both starts and concludes with Student A, as with Yacci's diagram. The main difference is the specific inclusion of ICT between the student and lecturer; i.e. the originating message goes from Student A to ICT Interface (*1a*) and from ICT Interface to Lecturer (*1b*). In this in-class interactive loop, the message back is not mediated by ICT. Figure 3.3 (below) shows Interactive Message Loop 2, in which the lecturer's reply is mediated by ICT:

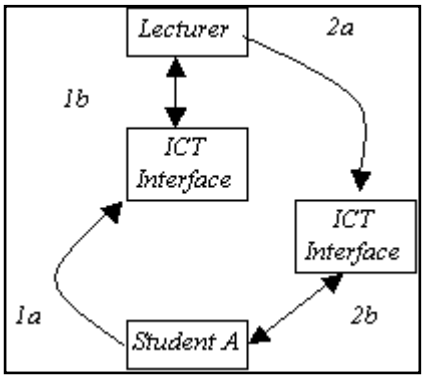


Figure 3.3 Interactive Message Loop 2: Student-Instructor Interaction (after-class)

Figure 3.3 (above) shows that the first half (*1a* and *1b*) of Interactive Message Loop 2 is the same as in Loop 1: the originating message goes from Student A to ICT Interface (*1a*) and from ICT Interface to Lecturer (*1b*). The variant between Loop 1 and Loop 2 is that the lecturer's reply (*2a* and *2b*) is mediated by ICT. The final permutation of an interactive message loop within this project is shown in Figure 3.4 (below), a message loop involving two students:

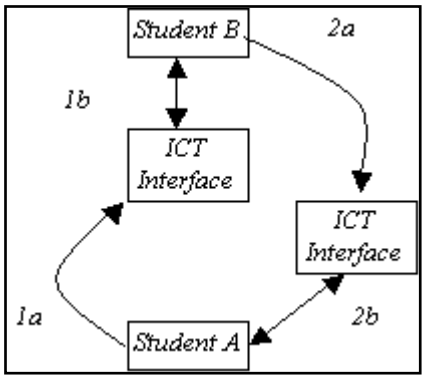


Figure 3.4 Interactive Message Loop 3: Student-Student Interaction (after-class)

In Figure 3.4 (above), the interesting item to note is how both the lecturer and other students can reply using an ICT interface, allowing the message loop originated by Student A to be replied to by any and all of the classroom participants.

Determining the ICT Interface

Two tools (ICT Interfaces) were developed to support the project's interactivity approach and to facilitate students' learning. The tools are used in tandem. The first tool is an in-class interface to capture a student's initial interactive message. The second tool is an after class interface allowing the lecturer and other students to

respond to the initial message. Both tools were designed following the guidelines below, earlier elucidated in the Literature Section:

- Student-instructor, student-student and student-content interaction are facilitated, to allow interactions to build on one another (Moore, 1989)
- All students can ask questions and comment (simultaneously if needed) without interrupting the in-class activities; interaction can continue after class (Liu *et al.*, 2002)
- Student participation is anonymous, as in Classroom / Personal Response Systems, to promote greater interaction and student accountability (Davis, 2003; Draper & Brown, 2004; Woods & Chiu, 2002)
- The focus is on familiar technology, to achieve a smooth, low-technology threshold for teachers and students (Muhlhauser & Trompler, 2002; Papert, 1980)
- Handhelds are used to achieve low-cost, one-to-one student-ICT device ratio (Roschelle & Pea, 2002) and anytime, anywhere usability (Savill-Smith & Kent, 2003)
- The initiation of interactivity is via SMS, the killer application of mobile phones and an area targeted for future educational research: UltraLab (Mitchell & Doherty, 2003) and MediaLab Europe (Ananny *et al.*, In Press).

Developing the In Class ICT Interface

As the interactivity originates with students' mobile phones sending SMS, the first tool design decision is how to receive and capture students' SMS. The author researched commercial models for receiving messages, but most did not suit this project due to high cost, lack of mobility, or complex interface. Instead, the researcher modified existing software from the MediaLab Europe (MLE) that interfaces with a Nokia Card Phone 1.0. Figure 3.5 (below) shows the modified ICT interface designed for this project:

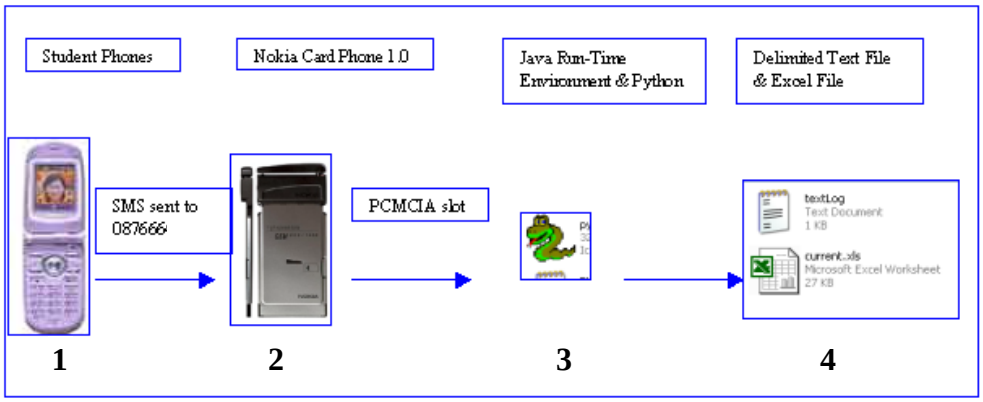


Figure 3.5 Project Interface Using Modified MLE Software

Figure 3.5 (above) begins with students sending their SMS from their own phones to a central class mobile phone number (**1**). The SIM card for this number is locally hosted on a laptop where a Nokia Card Phone 1.0 is installed in the PCMCIA slot (**2**). The modified software, using Python scripting within a Java Run-Time environment, captures sent SMS messages (**3**). The final format is a locally stored delimited text file continuously refreshed into an Excel file for viewing on the aforementioned laptop (**4**).

The key strength of the in-class tool is that it allows multiple students to initiate interaction using their personal mobile phones and the low-threshold application of SMS. While mobile phone numbers are recorded in the file log, this is not available to the lecturer or fellow students, ensuring anonymity and supporting greater interactivity. The use of mobile phones, a mobile modem and a laptop allows for a portable classroom – with anywhere usability.

Limitations that are addressed with the design of the second tool, the after class ICT interface, are time and participants. The students' initial interaction is not anytime, but rather in class. Since the lecturer mediates this tool, the initial project interaction is student-instructor. The second tool must therefore facilitate broader interaction, to

allow for student-student / student-content interaction and interaction outside of class times.

Developing the After Class ICT Interface

The second tool is an after-class interface to allow anytime access for the lecturer and all students, facilitating broader interaction. A database-driven website allows for anytime access to the content of the interactive message loops. Through the use of passwords, different access levels can be set *per interaction loop* for the message originator, the lecturer and other students. MySQL was selected as the web-based database, with php embedded in the web pages to set user options, search, locate, display and load data from MySQL.

Referring to figures 3.2, 3.3 and 3.4 (above, diagramming Interactive Message Loops 1 - 3), the after-class options available to the originating student, in relation to her SMS, are as follows:

- Read the original SMS (All Loops)
- Read the lecturer's comments (Loops 1 –2)
- Read other students' comments (Loop 3)
- Amend the original SMS (All Loops)
- Mark the interactive loop as closed (All Loops)

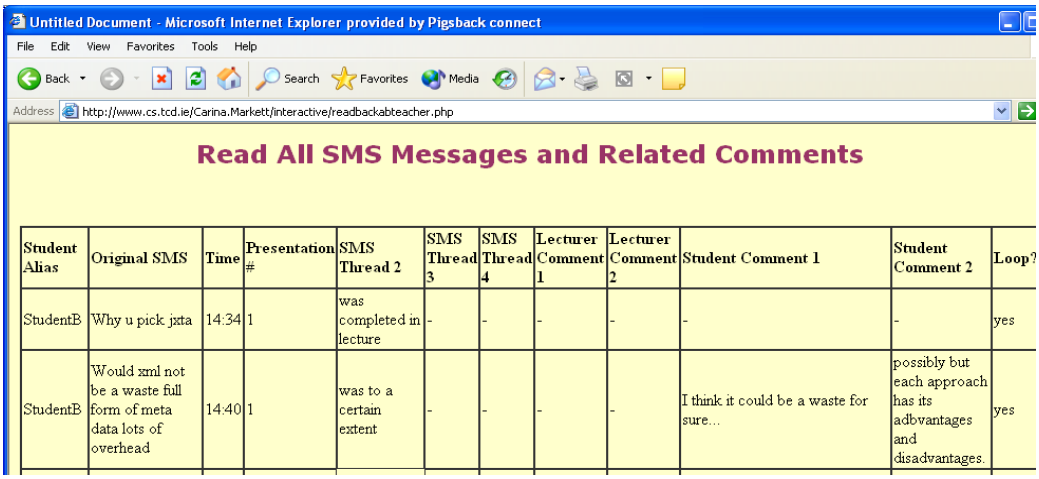
The after-class options available to the lecturer, in relation to all SMS, are as follows:

- Read the original SMS (All Loops)
- Read the originating students' amendments / loop comment (All Loops)
- Add a lecturer comment (Loops 1 –2)
- Read other students' comments (Loop 3)

The after-class options available to all students, in relation to others' SMS, are as follows:

- Read the original SMS (All Loops)
- Read the lecturer's comments (Loops 1 –2)
- Read the originating students' amendments / loop comment (All Loops)
- Add a comment (Loop 3)

The key strength of the after class tool is the multiple loops of interaction that it encourages: student-instructor, student-student and student-content. An interesting feature is the threaded organisation of the SMS on the website, whereby the original student, the lecturer and multiple other students can interact around one SMS. The screenshot below illustrates the threading:



Student Alias	Original SMS	Time	Presentation #	SMS Thread 2	SMS Thread 3	SMS Thread 4	Lecturer Comment 1	Lecturer Comment 2	Student Comment 1	Student Comment 2	Loop?
StudentB	Why u pick jxta	14:34	1	was completed in lecture	-	-	-	-	-	-	yes
StudentB	Would xml not be a waste full form of meta data lots of overhead	14:40	1	was to a certain extent	-	-	-	-	I think it could be a waste for sure...	possibly but each approach has its adbvantages and disadvantages.	yes

Figure 3.6 Sample Threading of SMS Messages and Postings

The database behind the website continues to ensure anonymity for the originating student, and provides anonymous posting of student comments. MySQL / php supports numerous simultaneous users anytime and allows limitless additions to the thread. In addition, the actual website design (shown in Figure 3.6 above and 3.7 below) is straightforward, providing a simple online user interface. Figure 3.7 (below) is a screenshot of a student's options following login.

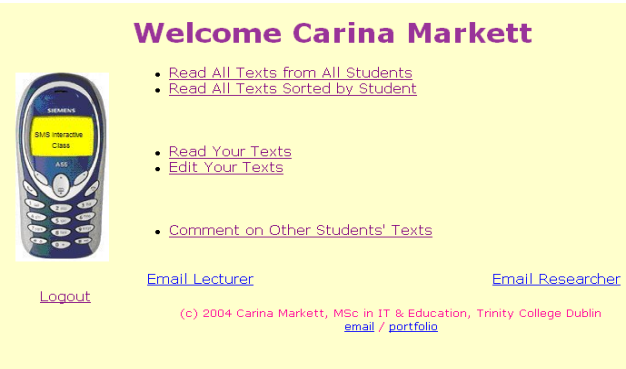


Figure 3.7 Student Index Page

Linking The Two Tools: One Artefact

As stated earlier in this section, the in-class tool captures SMS data in text and Excel files. Participant interaction with the after-class tool, a website, is driven by the data collected in class. Therefore, the two tools need to be linked; i.e. the in-class data populates the MySQL database after class. Originally, the upload was to be automated: the lecturer would upload the text log file to the server and a php script would run to parse the data into the correct fields in the MySQL database. Due to time and resource limitations, it was decided that it would be manageable for the researcher to manually enter the data into the MySQL database. The flowchart below, Figure 3.8, illustrates the artefact's overall structure and interaction:

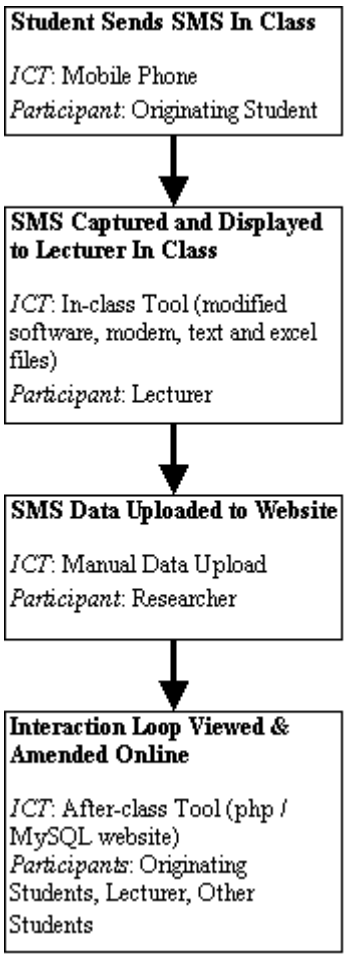


Figure 3.8 Flowchart of Project Artefact: Structure and Interaction

Technical Design Documentation

The following design documentation is included in the Appendix, highlighting the more technical aspects of the website design. In addition, the supplementary compact

disc contains the web pages, created using Dreamweaver MX, which shows the php coding.

- Additional Design Notes
- In-Class Tool: Directions to Start
- Flowchart of Student Website Interface
- Flowchart of Lecturer Website Interface
- MySQL Database – Fields in Users Tables
- MySQL Database – Fields in Texts Tables
- Website Design – Page Function and Links
- Data Display and Editing

Conclusions

The design of the artefact was one of the most challenging aspects of this project. All along, the primary pedagogical focus – interactivity – needed to remain in the forefront. Basing the project design on interactivity brought four 'participants' into all stages of design: the initiating student, the lecturer, other students and the ICT interface. Because the interaction needed to extend beyond in-class time, into anytime, anywhere usability, two ICT interfaces (tools) were developed, each with different technical constraints.

To create a simple and robust in-class tool, extensive research into existing and developmental SMS technology was conducted. Once the in-class tool was selected and modified, research was needed to ascertain what website solution would best work. Finally, the manual link between the two tools led to the complete artefact.

Working with one of the lecturers involved in the implementation allowed for iterations in design before implementation. For example, the preliminary in-class design put unnecessary constraints in place, affecting how the lecturer could interact with the students. These constraints (relating to time delays in viewing received SMS) would have prevented the realisation of the in-class loop between student and lecturer. In addition, the initial website design lacked the threading and editing functions to facilitate multi-participant interaction across time and place (i.e. student-lecturer in class followed by student-student after class). These difficulties are mentioned to reiterate how intertwined the pedagogy and technology, and

methodology and evaluation (discussed in the next section), are in this project's design.

Section 4: Methodology and Evaluation

Introduction

The implementation of this project consists of several stages. The first stage in implementation is the selection of the classes involved, project logistics and completion of pre-project questionnaires. The second stage includes project work both in-class and after class, including limited modifications to the project design. Finally, student post-project questionnaires and lecturer interviews were completed.

This section begins with a discussion of the research approach selected. This is followed by a review of the classes selected for the project, focusing on the relationship between course material, course ethos and innovative ICT usage. Third, the logistics of the project implementation are reviewed: number of class meetings and the planned activities during the implementation. Finally, the author moves step-by-step through the actual implementation, noting instances and methods of data gathering.

Research Approach

The research approach selected is an exploratory case study. Yin proposes case study as a preferred approach when "the focus is on a contemporary phenomenon within some real-life context" (2003, p. 1). The case study approach allows detailed focus on the part of the researcher, "to concentrate on a specific instance or situation and to identify, or attempt to identify, the various interactive processes at work" (1999, p.11). The small-scale implementation of a new ICT interface in two classes at a university in Ireland is a very practical and limited instance to study, as the case ends when the classes end. A clear end point avoids one of the feasibility pitfalls of case study, unclear definition of the *case*, as raised by Yin. In addition, through the use of a two-case study design, the vulnerability of the study is decreased while the potential for strong analytical work is increased.

Selecting Project Classes

This research project was conducted in two classes during the final academic term. The first class selected (referred to as Class A) was a first-year course, Computers and Society, required in a four-year Computer Science degree. This class was selected because the lecturer has an established record in using innovative ICT in the classroom, particularly in relation to the Computers and Society course. Published research exploring this course asserts: "the message of the course – issues to do with the "Information Age" – is embedded in the medium – information age schooling!" (Tangney, Holmes, & FitzGibbon, 2000, p. 380). Both students and the lecturer are familiar with one method of monitored, text-based interaction – email – as the lecturer monitors the students' group email distribution list when assessing group projects. There are 48 students in the course, but attendance in the last term hovers between 14 and 25 students. As a first-year computer science class, the age group is 18- to 19-year old and predominantly male and Irish. There are a handful of female foreign exchange students.

The second class selected (referred to as Class B) was the Master in Science in Ubiquitous Computing, a new two-year full-time Master's course. It is a very intensive course that prepares students for professional and academic careers. The students' age range is upwards from 22-years, with the majority of students (all male) in their mid-twenties. As with Class A, the course material - mobile and ubiquitous computing systems - links well to the guiding literature of this project's development.

The Class A students were introduced to the project as a given; i.e. the lecturer had agreed to implement the project and students could choose whether to interact with the SMS interface in class. In contrast, the Class B students were consulted prior to the project's implementation, and when agreeing to the implementation indicated that they were very enthusiastic about using SMS in class.

Project Logistics Within the Classes

Class A meets weekly for a 60-75 minute lecture, and the project was implemented in four meetings. The classroom layout is a sloped lecture theatre with stationary

seating. A multimedia projector and Internet access point at the lecturer's desk supplement the blackboard and overhead projector; while there is wireless access for students, students generally do not bring laptops to class. There are mobile phone signals for all three Irish networks. The following table shows main points regarding the Class A meetings in which the research project was conducted:

		Activity / Material	Students
Week 1	March 30	Project Introduced, Pre-Project Questionnaire	21
Week 2	April 6	Lecture Topic: Government & Impact on Technology	18
Week 3	April 13	Lecture Topic: ICT Trends in Society	14
Week 4	April 27	Lecture Topic: 100 Years of Women in Trinity College Dublin	16

Table 4-1 Schedule of Implementation, Class A

Class B meets in a small wireless classroom with a desk, whiteboard and multimedia projector at the front. As with Class A, the majority of students did not bring their laptops. The implementation in Class B occurred during two 2-hour meetings where students were presenting group projects; each presentation lasted an average of 25 minutes. The following table shows the main points regarding the Class B meetings in which the research project was conducted:

		Activity / Material	Students
Class 1	April 26	Project Introduced, Pre-Project Questionnaire Group Presentations 1 –3 on file sharing systems	17
Class 2	April 27	Group Presentations 4 – 6 on multimedia data communications	10

Table 4-2 Schedule of Implementation, Class B

Pre-Project Work

Both classes were introduced to the project's research and theory at the start of the first implementation meeting. The main points covered during the researcher's informal presentation were: the anonymity of participation, post-project reimbursement of SMS cost, the SMS interaction as an additional, voluntary medium of communication, and the after-class website interaction. Following questions, students were asked to complete a sign-up form, containing information for the researcher to assign website usernames, passwords and aliases. This allowed the

researcher to: link all received texts to a student alias, support anonymous website display by student alias, and enable sender editing of SMS.

The pre-project questionnaires were also completed at this time, consisting of 12 questions to elicit information on students' current interaction in the course. Three lecturers had previously reviewed this questionnaire, clarifying and validating the content and wording. In the questionnaire, students are asked about interaction: in class / after class, with students / the lecturer, and self-initiated / in response to others. The responses were graded from 1 to 5, based on a Likert scale, indicating either frequency of interaction or satisfaction with communication method. For collating purposes, students were asked to write their mobile number on all forms. Minimal background information was gathered regarding students' SMS usage: two questions focused on frequency of sending SMS (graded from 1 to 5) and use for academic purposes.

Implementation During Class

At the beginning of each class, students were reminded of the project's presence in the class, and the opportunity to send SMS to a central number. The number was displayed prominently at the front of the classroom. In the Class A implementation, the laptop displaying SMS was somewhat hidden from the students and located on the lecturer's desk; during class, he needed to move behind the desk to view the SMS. In the Class B implementation, the laptop displaying SMS was positioned next to the presentation laptop, fully visible to all students although the screen was only visible to the presenters. The presenters could view SMS by glancing in the direction of the laptop.

For all classes, the researcher was visible to students during the class, and either taking written notes (Class B and parts of Class A) or filming the lecturer (parts of Class A). One of the key points to observe was how the lecturer or presenters integrated the SMS interface into the class. Another key observation point for the researcher was the visibility of mobile phones in class, and whether students were using them.

The Use of the Website

Following each class meeting, the researcher manually updated the SMS messages on the class website. In Class A, following the first meeting, an email was sent that evening to all students explaining the website facility more thoroughly. An email was sent again after the third meeting to reiterate the role of the website within the project. In Class B, emails were sent to the class after both meetings.

Participants' use of the website was partially monitored. The researcher logged into the website to see whether the lecturer, SMS sender or other students added comments and if the SMS sender felt that the interactive loop was complete. As the website was hosted on a university server, college regulations on appropriate content needed to be observed; fortunately there were no questionable comments during the project's duration. The monitoring also served in determining if additional website functionalities were needed.

Post-Project Work

Students in Class B were given a printed post-project questionnaire to complete and return. Eleven students completed the post-project questionnaire, which contained eight questions (with sub-questions) focusing on: the project's effect on class atmosphere and respondents' interactions, the presenter's response to respondent's SMS, barriers in sending SMS, website use and future implementations and modifications. In addition, presenters were emailed six questions to answer in light of their presentation experience. A limited number of students in Class A completed the post-project questionnaire via email. Finally, the lecturers from Class A and Class B answered eleven open-ended questions (phone interview or written).

Technical Hitches and Modifications During Project Implementation

When setting up the SMS interface in the first 2 meetings of Class A, the SMS display shut down due to a bug just prior to the class start. The SMS interface was quickly re-booted, but the design was altered for the next implementation. The only other technical hitch during the implementation occurred during the final presentation in Class B. A presenter whispered that the SMS wasn't working; when the researcher looked at the screen, the automatic data update had been interrupted by a presenter

clicking into the Excel spreadsheet. The researcher was able to quickly re-set the automatic data update, and the previous 15 minutes of SMS appeared on screen.

Few technical hitches were discovered in relation to the website. One student (Class A) could not log on to the website; this was because his mobile phone number was inputted incorrectly from the sign-up form. A second student (Class A) sent an email to the researcher noting 2 php bugs: comments cannot be added if a preceding comment has an apostrophe and the system allows for blank inputs. Neither of these bugs thwarted the implementation; it was decided that relevant modifications would be made in future implementations.

Conclusions

There were many challenges inherent in this project's design that affected the implementation, in some ways making it quite rigid. The need to track users via their mobile phone numbers led to a significant amount of paperwork, with the immediate after-class website update requiring a sizeable time commitment on the researcher's part. However, in relation to the work done by students and lecturers, the implementation plan proposed at the start of classes was maintained throughout, offering consistency and a robust SMS and website interface for participants.

The next section, Section 5, details both data collection and analysis, and summarises the project's findings.

Section 5: Findings and Conclusions

Introduction

As discussed in Section 4, the key factor when designing this project was to support participants in understanding and using an interactive message loop. Therefore, the main focus of the findings relates to the interactive loop and is addressed using a variety of data sources, as recommended with case studies. The evaluation methods used were: direct observation (researcher's diary and reflections), questionnaires (pre- and post-project), phone interviews and SMS and website data capture.

This section begins with a review of Yin's three principles of data collection that helped to guide not only data collection, but also data analysis in this project. Then a discussion of findings / analysis occurs, following the general structure shown below:

Analysis	**Source**
Pre-Project Class Interactions	Pre-Project Questionnaire
Volume and Frequency of SMS	In class SMS data capture
Volume and Quality of Website Use	After class website data capture Pre-Project Questionnaire
Educational Content / Communicative Use of Interactive Loop	After class website data capture
Comparative Analysis	Pre-Project Questionnaire, In class data capture, After class website data capture
Summary of Project Interaction and Future Uses / Changes	Post-Project Questionnaires

Table 5-1 Analysis, Source of Data Collection

Table 5.1 (above) provides a roadmap to this section based on the key analysis. The concluding sub-sections close the dissertation: bringing together the analysis, contextualising the research project and suggesting areas for future research.

Yin's Three Principles of Data Collection

In case study research, the researcher may have minimal control over events within the project's scope. Yin (2003) cites this as one reason that case studies, more than experiments or surveys, benefit from multiple data sources. The use of multiple data sources is the first of Yin's three principles of data collection. In this project, each source of evidence is analysed separately, with later comparison of results from the different analyses, without actual triangulation. Creating a case study database is the second principle as it allows readers or subsequent researchers access to the raw data. In this project, the researcher has collated all data (excluding references to identifying personal data) into a case study database that is available on the supplementary compact disc. Proper use of a case study database, together with the written dissertation that references the source of all findings, allows for a full chain of evidence (Principle Three). According to Yin, the chain of evidence increases "the reliability of the information in a case study" (p.113).

Pre-Project Class Interactions

The pre-project questionnaire focuses on two main areas: student use of SMS, and frequency of interaction in class / satisfaction with interaction method. By focusing on these areas, comparisons can later be drawn between pre-project and project interaction.

In both classes 100% of students owned mobile phones. Figure 5.1 (below) charts the frequency that students *send* SMS.

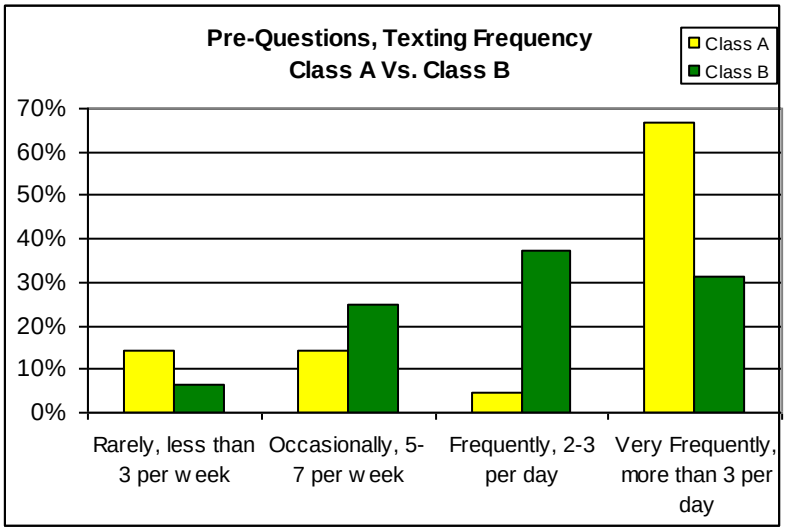


Figure 5.1 Texting Frequency, Class A Vs. Class B

While variances exist between Class A and Class B when analysing by specific category, the combined results of *Frequently (2-3 per day)* and *Very Frequently (more than 3 per day)* are similar per class (71% and 69%). The second question relating to SMS usage shows students in Class B using SMS for academic purposes at a much higher rate (31%) than those in Class A (19%).

In relation to students' interactions in class, the following seven questions were asked:

4a	Do you ask the lecturer a question in class?
5a	Do you answer the lecturer's question in class?
6a	Do you address a fellow students' comments in class?
7a	Do you answer a fellow students' question in class?
8a	Do you engage in an extended dialogue with the lecturer in class?
9a	Do you email the lecturer with a question after class?
10a	Do you arrange to meet with the lecturer after class?

Students were then asked to rate the frequency of interaction from 1 to 5 according to this scale:

1	Never
2	Rarely (less than once per term)
3	Occasionally (2-3 times per term)
4	Frequently (once per class)
5	Very Frequently (more than once per class)

Finally, students were asked to rate their satisfaction with the method of communication by this scale:

1	(Not Satisfactory)
2	(Slightly Satisfactory)
3	(No Opinion)
4	(Satisfactory)
5	(Very Satisfactory)

The results of these seven questions in relation to frequency are shown in Figure 5.2 (below):

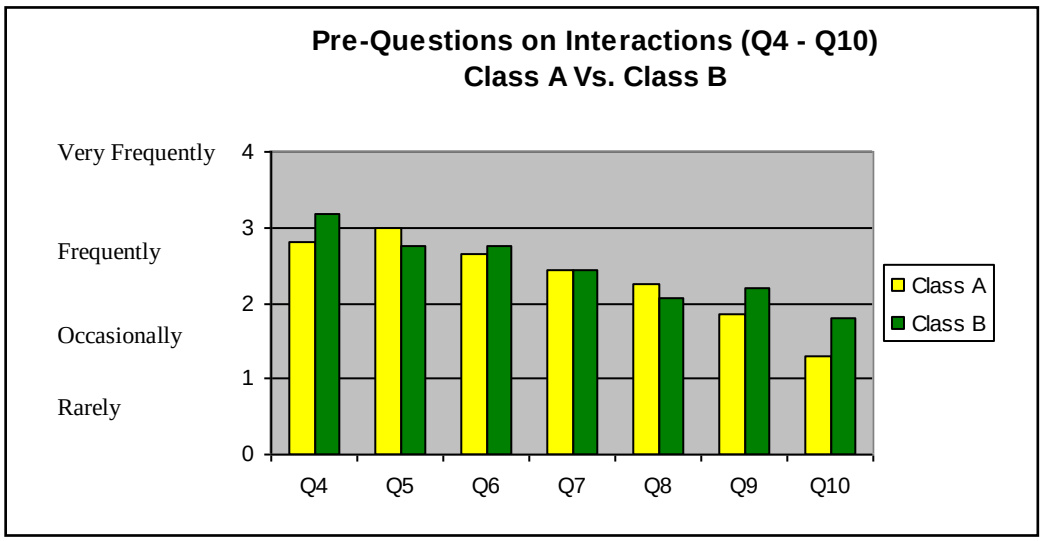


Figure 5.2 Interaction Frequency, Class A Vs. Class B

In pre-project discussions with the project's lecturers, both felt that their classes had a high level of in-class interactivity. In Figure 5.2 (above), Questions 4 to 8 relate to in-class interaction and have an average response of less than 3. This indicates that per student, interactivity is more *occasional* than *consistent*. In regards to after-class interaction (email and meetings), frequency is lower, veering towards rarely. However, Class B has greater frequency in this type of interaction. Figure 5.3 (below) examines the satisfaction levels in relation to interaction methods.

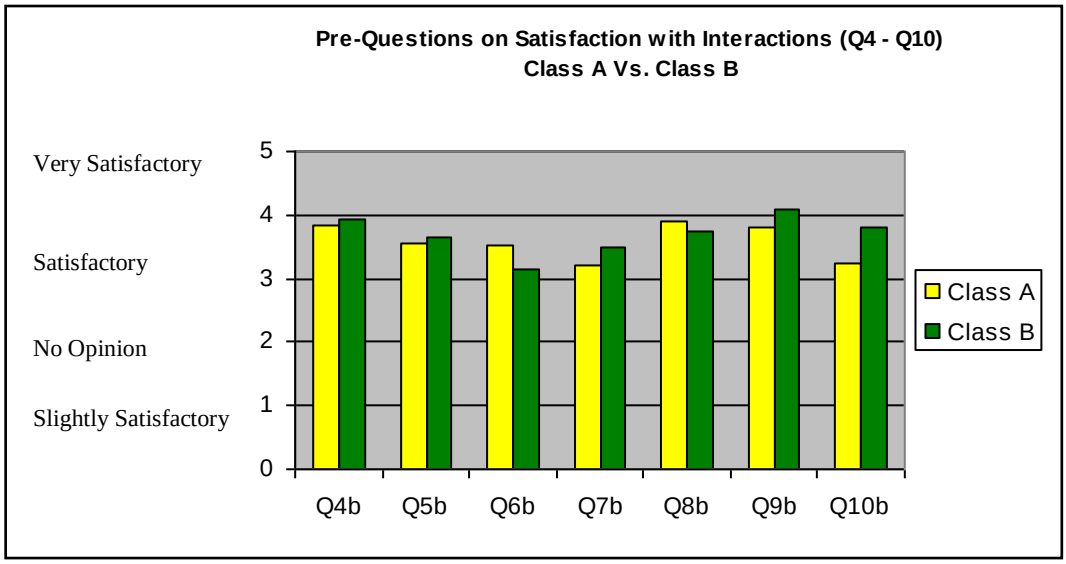


Figure 5.3 Satisfaction with Interaction Method, Class A Vs. Class B

In terms of satisfaction, for Class B the three highest satisfaction averages correspond to *student-initiated interaction with the lecturer* (asking questions in class, emailing or meeting the lecturer). For Class A, two of the three highest satisfaction rates correlate to *student-initiated interaction with the lecturer* (asking questions in class, emailing). This data correlates with Anderson's assertion that "student-teacher interaction currently has the highest perceived value amongst students" (2002). In general, across all interaction activities, the average satisfaction rating is positive.

Volume and Frequency of SMS

As discussed in the methodology and evaluation section, there were three meetings for Class A and two for Class B. During the project, Class B had a much higher percentage of students sending SMS, as shown in Figure 5.4 (below).

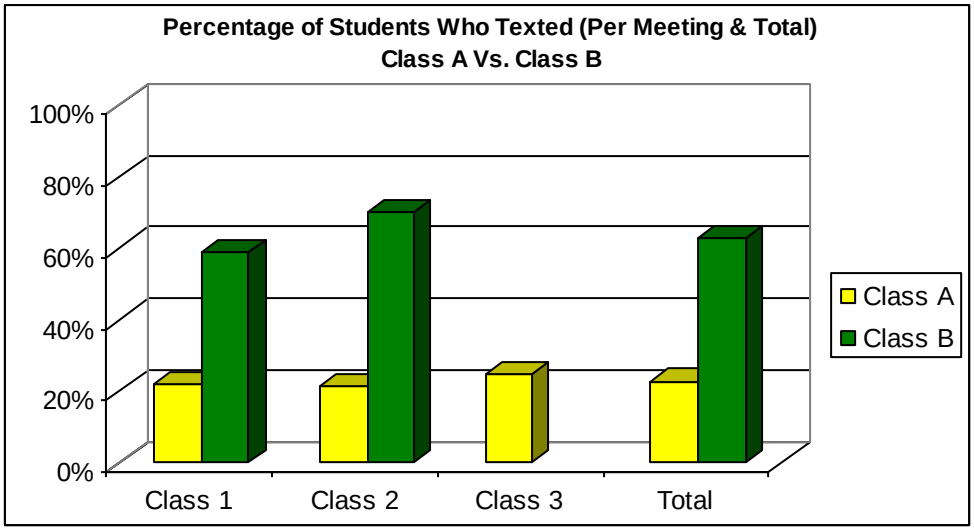


Figure 5.4 Percentage of Students Who Texted, Class A Vs. Class B

An interesting observation is that while Class B attendance dropped by 41%, the percentage of students who texted increased by 11% with final participation at 70% (plus the lecturer). Meanwhile, the percentage of students texting remained fairly constant in Class A. In addition to analysing participation rates, it is useful to examine the frequency of participation, shown in Figure 5.5 (below):

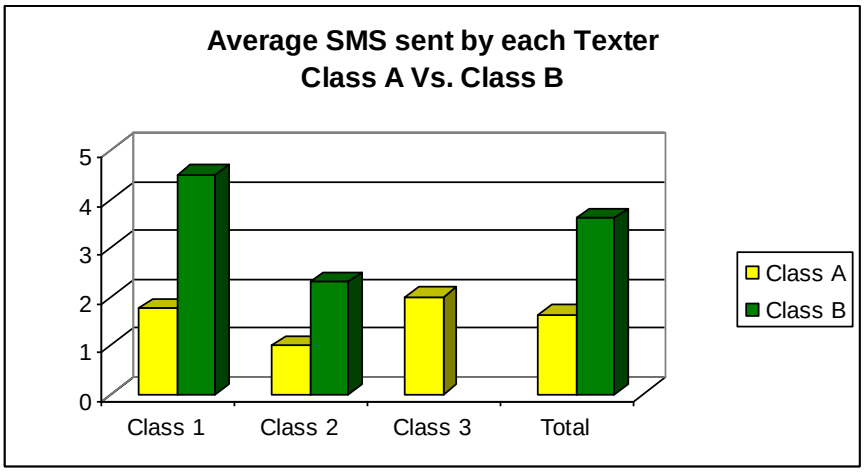


Figure 5.5 Average SMS Sent by Each Texter, Class A Vs. Class B

The variation in number of SMS sent per texter should be examined in greater detail. Are the texters changing from meeting to meeting, or is all the data due to the same texters? In Class A, six students texted in only one meeting, while two students texted in two or three meetings. In relation to Class A, it is impossible to know whether the

students who texted singly actually attended multiple meetings since attendance was not monitored. In contrast, knowing who attended the Class B meetings, the texters were more consistent: six texters attended and texted in both meetings, with only two texters attending both classes but texting in only one. There were seven non-texters in Class B's first meeting, and three in its second meeting.

Volume and Quality of Website Use

The main pedagogical functions of the website were:

- To facilitate broader interaction: simultaneous, anytime, anywhere
- To allow multiple, limitless interactions around one originating SMS: student-instructor, student-student and student-content.
- To support different access *per interaction loop* for the message originator, the lecturer and other students
- To ensure anonymity for all student participants

As the website design did not incorporate monitoring of who logged in, for data on website access, the Class B post-project questionnaires (61% completion) are analysed. Only two students in Class A completed the post-project questionnaires; their results are not included in this analysis. In Class B, 91% of respondents accessed the website, and 80% felt that the website 'helped their understanding of concepts / materials covered'. This is a significant result, indicating that the website could facilitate student-content interaction. In addition, of respondents who would 'like to have the opportunity to send SMS in future classes', 29% suggested greater use of the website as a future change. This corroborates the website's positive role in this project, although suggesting that its present use is not sufficiently integrated into the overall framework.

An examination of the data added via the website will indicate: who accessed the site (originating student, lecturer or other students), what access per interaction loop occurred (closing the loop, clarifying originating SMS) and whether multiple interactions around one originating SMS occurred. Figure 5.6 (below) summarises these issues:

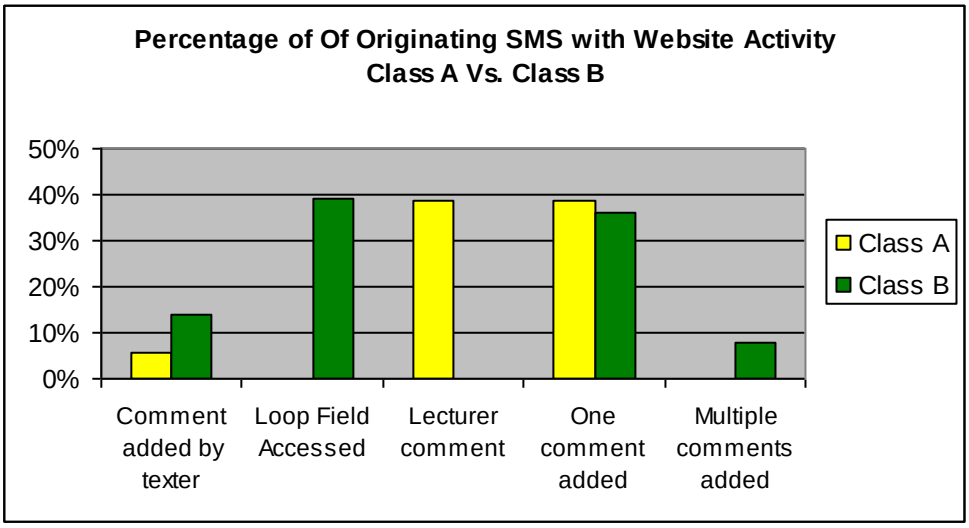


Figure 5.6 Percentage of Originating SMS with Website Activity, Class A Vs. Class B

With over 35% of SMS in both classes being commented upon by other students, the level of interaction between students appears quite high via the website. Class B appears to use the website more for extended dialogue than Class A, as 14% of SMS were commented upon by the original texter, 39% had the loop complete field edited, and 8% of SMS had multiple threaded comments. Of the students in Class B who edited the loop complete field, 80% indicated that the loop was closed.

Educational Content / Communicative Use of Interactive Loop

The content of the originating SMS and website comments is analysed to provide an understanding of how participants used this interactive medium; i.e. spurious, political, greetings / jokes, content questions, content comments, administrative questions or style comments. The researcher made the categorisations based on observations of class content (i.e. a question on literature would be spurious within Class B). However, given the broad societal content in Class A and the level of specialized content in Class B, the message categorisations are more subjective than other analysis methods utilised in this research.

In-class SMS totalled 18 for Class A, over three class meetings, making it difficult to find a pattern in the SMS content. In brief, 61% of SMS were related directly to class content, taking the form of comments or questions. Non-content related messages included opinions on student teams, mathematical equations and quotes from Animal Farm. Content-related SMS includes:

> *Our education system is based on the divide i went2a a 1gender school& 1 of there selling points was the fact pupils wouldnt be distracted in their studies*
>
> *Is it really worthwhile having anti-tech on a technology commision?*

In-class SMS for Class B had a slightly higher level of content relation (78%), with 65 messages analysed. An interesting observation is that while in the first class there were greeting/jokes, in the second class there were none. However, in the second class, a new communication use was shown: references to the presentation style (*speak up*; *why are there so many slides*). It would be interesting to see the effect a longer project implementation would have on these types of uses: Would greetings and jokes decrease as the novelty faded? Is SMS a useful way to pass style notes to the presenter?

Many of the content-related SMS in Class B posed similar questions; for example, Presentation Two had four questions within one minute regarding security. In the post-project interview, the lecturer noted: "*a number of questions were related to the same topic. Some students asked if it would be possible to identify these questions and collect them together to a single question."* Since the in-class tool displays SMS only to the lecturer, students are effectively composing their SMS in isolation, leading to repetition of questions and comments.

Examining the threads found on the website can give a further indication of the educational content and communicative uses of the overall artefact. The following are threads from Class B, with notes on the uses of the thread:

Straightforward Clarification Question / Answer

1. *Originating SMS* Do files have to be saved as small chunks or are they split up when they asked for download.
   Other SMS File fragments are downloaded to different clients they then swap the file fragments.

2. *Originating SMS* torrent file small means u cant share avi files. I guess no.
   Other SMS No thats missing the point. The torrent file is small and that lets you get the large avi (or whatever type of file)

3. *Originating SMS* what does IETF mean?
   Other SMS The Internet Engineering Task Force

Clarification Question / Link to Further Information

4. *Originating SMS* Is it an open protocol?
   Other SMS Yes. Check out http://bitconjurer.org/BitTorrent/

Clarification Question / Conflicting Answers

5. *Originating SMS* Why did they need to reverse engineer if it was under gnu?
   Other SMS They didnt the presenter was wrong :)
   Other SMS reverse engineered cos aol would not release it, and the later versions were under gnu

Unclear Comment with No Answer

6. *Originating SMS* Wrong! All wrong!
   Other SMS whats wrong
   Other SMS yeah whats wrong??

As the above sample threads show, where either the presenter or other students gave a response, the correlation in content within the thread was quite strong. This links to the following chart showing participants' assessment of the level of response from the lecturer:

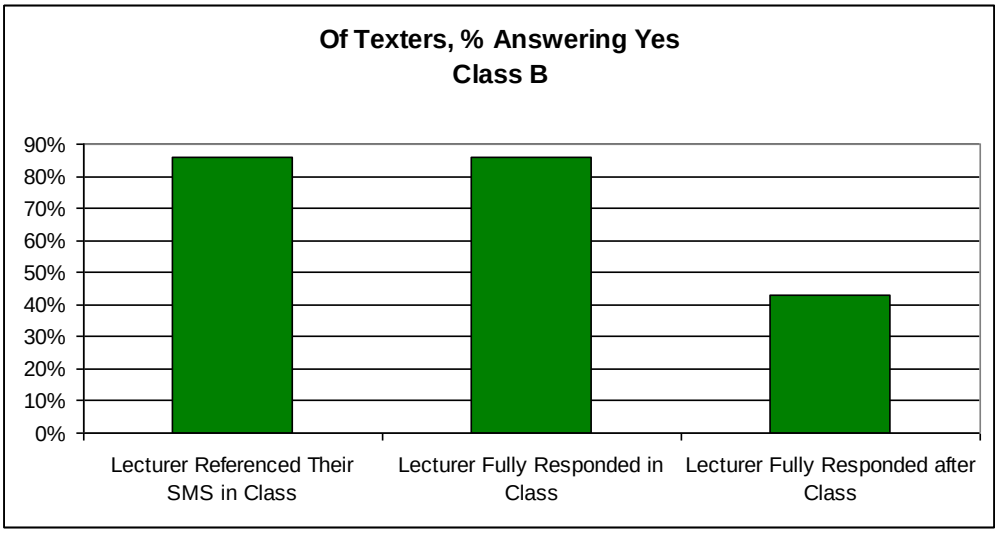


Figure 5.7 Of Texters, % Responding 'Yes' in Relation to Lecturer's Responses

As Figure 5.7 (above) shows, students' assessment of the lecturer's use of the interface is quite high. The Class B lecturer agreed that the presenters made good use of the tool: "*The students used the interface to get a feeling for the reception of the material by the class. This feedback through the SMS interface gave the presenters a better feeling if the class followed the presentation."* The use of the in-class tool to sense students' understanding, indicates the possibility of using the tool for contingent teaching, as explored by Draper *et al.* (2004).

Comparative Analysis

A useful comparative analysis is whether there is a correlation between students' agreement to the following statements regarding public speaking / identification and their use of the SMS interface. While the statements don't directly reference students' need for anonymity, the correlation should be examined:

- Q11a "I don't like public speaking"
- Q11b "I don't like fellow students knowing my questions /comments"
- Q11c "I don't like the lecturer knowing questions /comments"

In Class A, two of the four students who *strongly agreed* and two of the eight students who *agreed* with Q11a sent SMS; indicating that 33% of these students used the SMS interface. In Class B, both students who *strongly agreed* and four of the five students who *agreed* with Q11a sent SMS. This is an in-class interface usage of 86%. In both

classes, the students who don't like public speaking have a higher access rate to the system than the class average. Descriptive evidence from students supports this: "*It gave people who were normally shy the chance to have their say".*

In relation to student–student interaction, 41% of Class A students and 75% of Class B students who *agreed* or *strongly agreed* with Q11b sent SMS. This is also a higher access rate to the system than the class average. Finally, in relation to student-lecturer interaction, 38% of students in Class A who *agreed* or *strongly agreed* with Q11c sent SMS, also above the class average. In Class B, no students agreed with Q11c. A discussion of reasons for aversions to public speaking / identification is beyond the scope of this research, however, the following student comment reverberates issues on this subject covered by Davis' (2003) work on Classroom Response Systems:

> *"While giving the presentation, a couple of issues came up via SMS that probably wouldn't have been asked otherwise, i.e. people wouldn't want to ask if they think it's obvious and they should know"*

Without exploring reasons for it, the Class A lecturer noted that:

> *"some, a few, comments were made that wouldn't be made otherwise – dad micro, your personal beliefs - conversations that wouldn't have occurred without technology."*

This comparative analysis of attitudes towards public speaking / identification and SMS sent strongly suggests that students who do not like public speaking / identification may take up the SMS interface in larger numbers than the rest of the class. As a correlation, responses to Question 4 (asking the lecturer a question in class) are examined in detail. In Class A, eight students never or rarely ask the lecturer questions in class; none of these students sent an SMS. However, in Class B, of the four students who never or rarely ask the lecturer questions in class, two of them sent SMS (sending 4 & 10 SMS in total). The question cannot be directly correlated in Class B since the class format was student presentations, and the pre-questionnaire did not address student presentations. However, descriptive evidence suggests greater student-student interaction:

> *"There were more questions asked, as these were student presentations we usually don't interrupt."*

"There was more contact between presenter and class."

Not all students felt the need to utilise the anonymous, discrete format of SMS:

"There were no questions I didn't want to ask in the open for any reason"

Summary of Project Interaction and Future Uses / Changes

In response to basic questions on interactivity, 82% of respondents in Class B felt that level of class interaction was affected during the project. A playful elaboration on this was "*more happiness, more interesting*", with a straightforward summation by a second student of: "*there was more contact between presenter and class*."

Students were then asked about their own interactions in class, 64% of respondents felt that their interactions were affected. This effect included: "*ask questions freely*", "*I asked more questions*". The fact that this was a new method for interaction prompted one student to suggest, "*I think it* [the effect on my participation] *was down to the novelty*".

Many barriers were identified in relation to using the SMS interface; 86% of respondents found barriers. Six students found sending an SMS time-consuming, three found it distracting (for themselves or the presenter) and one student each noted the time delay in receipt of messages and the noise associated with clicking.

One possible barrier to institutional acceptance of the use of SMS in class is the private link that mobile phones give students to outside the classroom. With this in mind, students who had their mobiles on during class were asked three questions to determine if the mobile phone was used for external contact. No respondent sent SMS outside of class, but 10% sent one to a classmate. Fully 50% of respondents read SMS that they received during class. The contrast between the two results should be studied further as some lecturers may express concern over losing their students' attention to outside SMS.

Concluding the post-project questions, students were asked about future implementations. The chart below shows the activities for which students believe the SMS interface is appropriate:

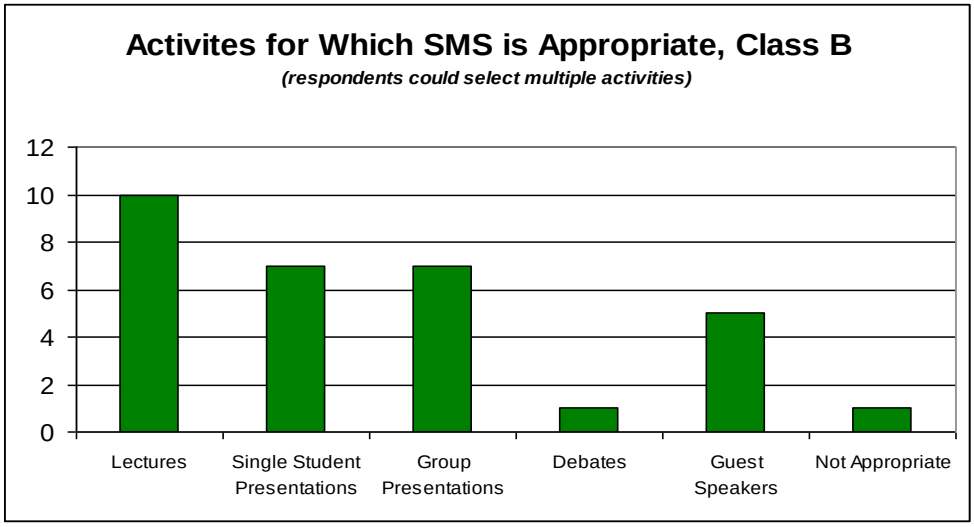


Figure 5.8 Activities for SMS Implementation, Number of Students Selecting Options

An interesting observation relating to the suggested activities is that while students experienced the implementations during presentations, more students indicated that the interface was appropriate for lectures. One student captured issues of barriers to interactivity (as discussed previously) when suggesting implementation in lectures:

> *"Probably useful in undergrad lectures, esp. for first year or two where people tend to be more self-conscious about asking stupid question"*

An additional suggestion was for:

> *"Intensive weekend or day course, where time is premium"*

As discussed previously, the majority of students felt that there were barriers to sending SMS in class. It is no surprise that changes were suggested for future implementations. These changes included free SMS (45%), greater use of website (18%), display of SMS messages to students (9%), use of a 'proper keyboard', use of Bluetooth.

The final analysis question reports that 64% of students in Class B would like to use SMS in future classes, versus 27% who would not. Both lecturers expressed an interest in using SMS in some classes.

Concluding Remarks

As mentioned at the start of this section, the primary concern of the analysis was to determine if students used the in-class and after-class tools to understand and participate in interactive loops. The data analysed indicates that students were receptive to using SMS in class, with SMS rates of 32% for Class A and 70% for Class B. After-class website use for Class B was 91%, with 35% of messages online being commented on. This shows that the interactive loop is active in both project classes, and further analysis of the online thread content indicates that issues raised in class are being examined and responded to after class. With lecturers using the interface in class – referencing students' SMS and monitoring student understanding - broader interaction (anytime, anywhere, simultaneous) with multiple levels (student-student, student-lecturer, student-content) is occurring.

The usage level of in-class and after-class tools compared favourably to other methods of communication such as asking / answering questions in class, commenting in class or emailing / meeting with the lecturer. All of these activities have an *occasional* frequency in class. However, as the project implementation was short term, it is difficult to predict whether the novelty of the interaction method has greatly affected the usage levels. A longer-term implementation, ideally beginning at the start of term and lasting through the whole term, would help to determine this.

The small number of participants completing the post-project questions limits the conclusions drawn above regarding participant's satisfaction with the components of the ICT-enhanced interactive message loop. However, from these respondents, it is clear that the opportunity to: use a new technology, view a variety of comments, respond in multiple mediums and text in class led to some satisfaction. The majority of students would like to see SMS used in class in the future, and suggested additional activities for which it would appropriate.

Limitations

The implementation occurred in the final term, when student attendance in lectures decreases and the general atmosphere in class has been established. Coupled with the small class size and meeting numbers, this research explores the issues which *may* arise when implementing SMS in the classroom within an interactive loop framework.

Future Developments

Future developments are mainly within the area of design of the website interface: fixing bugs, streamlining the data table, increasing student options for edits, tracking logins, and improving the visual appearance. The two bugs noted during the implementation were not crucial to the project's function, but would be fixed in future iterations. The MySQL data tables running behind the website have some redundant fields that caused unneeded data entry for the research; this will be streamlined. The limit of message and comment fields to 160 characters is logical when the data input all comes from SMS (also limited to 160) but redundant when users update fields via the website; the field size will be increased. The most significant change to the website is tracking logins to allow for greater data collection and traceability in relation to students' comments / edits. Finally, as the interactive loop is expanded in the website into a threaded conversation, designing the layout along the lines of a discussion board is a planned improvement.

As referenced by one student, the time delay in receipt of messages prevents the SMS display from being a dynamic and robust in-class interface. This delay, like the length of time it takes to compose messages, may be unavoidable. However, a strategy for smoother implementation could ensure that these barriers are less noticeable in future iterations.

The Big Picture

Using SMS in the classroom has excited and interested many of the students in this project implementation. The lecturer in Class A, commented "I've never seen you guys so quiet before" when the project was first announced. Students in this project, as expected from the literature, showed that they were comfortable with the technology used and with an educational use for their mobiles.

Students demonstrated that they were interested in interacting with both each other and the lecturer in class (sending SMS and responding when the lecturer read the SMS aloud) and after class (accessing the website, commenting on each other's SMS). While not every interaction concluded with a full interactive loop, the ICT tool raised awareness of the principles of the loop.

Researchers in the field of education have indicated an interest in looking at SMS for communication and content delivery. The specific focus on interactivity has not been fully explored. Hopefully projects such as this will encourage other researchers to look beyond the small things and look at the big picture of how we presently interact and how we may interact in the future. tks 2 txt.

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Section 7: Appendix

Appendix 1: Design: Additional Design Notes

Notes on the Modified Software for In Class Tool

The main strengths of the modified software interface are: free software, minimum hardware purchase requirement, and production of a small, versatile text file. Weaknesses that were identified and overcome include: as developmental software, some adjustments to the source code were needed, it works only on Windows 2000, and the use of an outdated Nokia product made it difficult to source the required hardware.

Approach to Website Design for After-Class Tool

The design of the class website was one of the most challenging aspects of the project. There are five key sections to designing the website. The table below summarises the design sections, programs used, and relevant appendices. There was no specific order in the website design, as each section impacted upon the others and design documentation (included in Appendix) was modified quite frequently.

#	Section	Programs	Appendices
1	Website Structure	Macromedia Dreamweaver MX	Website Structure – Page Function & Links Flowchart- Student Website Interface Lecturer Website Interface
2	MySQL Database Structure (Tables)	MySQL, phpMyAdmin	MySQL Database – Fields in Users Tables Fields in Texts Tables
3	MySQL Database Structure (Fields)	MySQL, phpMyAdmin	MySQL Database – Fields in Users Tables Fields in Texts Tables

4	php coding (data update/data entry, search & display of data)	Macromedia Dreamweaver MX, php	Supplementary cd: site files
5	Website Display of Data	Macromedia Dreamweaver MX	Data Display and Editing – Fields Per Page

Table 7-1 Website Design Sections

Section one of the website design involved determining the activities available for each participant. There were two types of participants: lecturer and student. The student and lecturer interface with the website is further explained in the flowcharts in the Design Appendices. Following the creation of a flowchart, the author determined which pages were needed and how they would link together. Sections 2 of the website design determines the tables in MySQL: one table to control users and a second to control content (SMS and comments). Combined with Section 3, the field design within each table, the distinct parameters are set for data to be entered, retrieved or edited. Section 4 was the most technically advanced aspect of the website design as it involved the actual php coding to control user options, search, locate, display and enter data. Php code acts a conduit between the tables/fields and the web pages. Finally, Section 5 refers to following standard practice in good website design: building a user-friendly layout that is easy to navigate and visually pleasing.

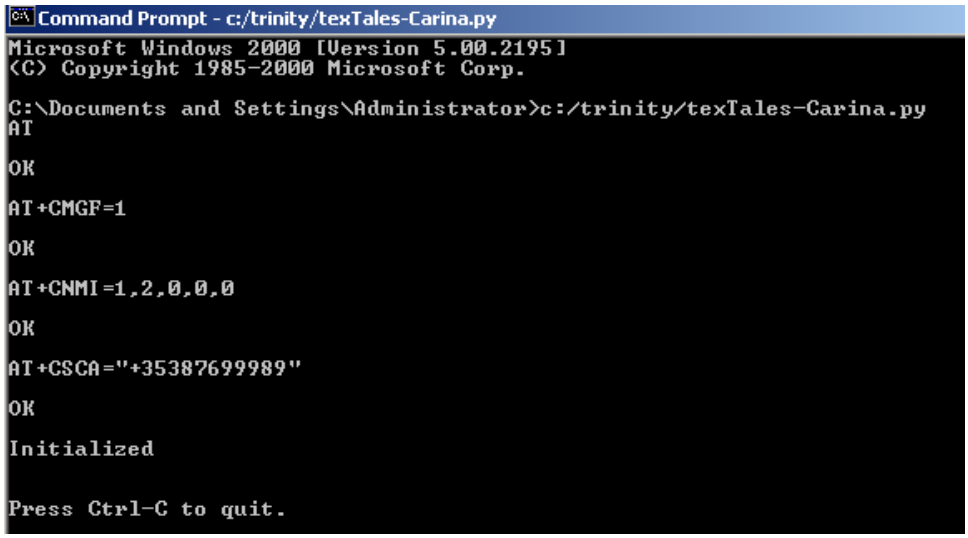
Appendix 2: Design: In-Class Tool: Directions to Start

The following need to be in place prior to class:

1. PC is loaded and tested with software provided on TexTales© cd from MediaLab Europe
2. Trinity folder is copied directly into 'C' drive

To accept texts during class:

1. Nokia Card Phone 1.0 is slotted into PCMCIA slot
2. Type the following in the DOS prompt
   C:\trinity\texTales-Carina.py
3. In the DOS prompt, the following will indicate that the software is working:



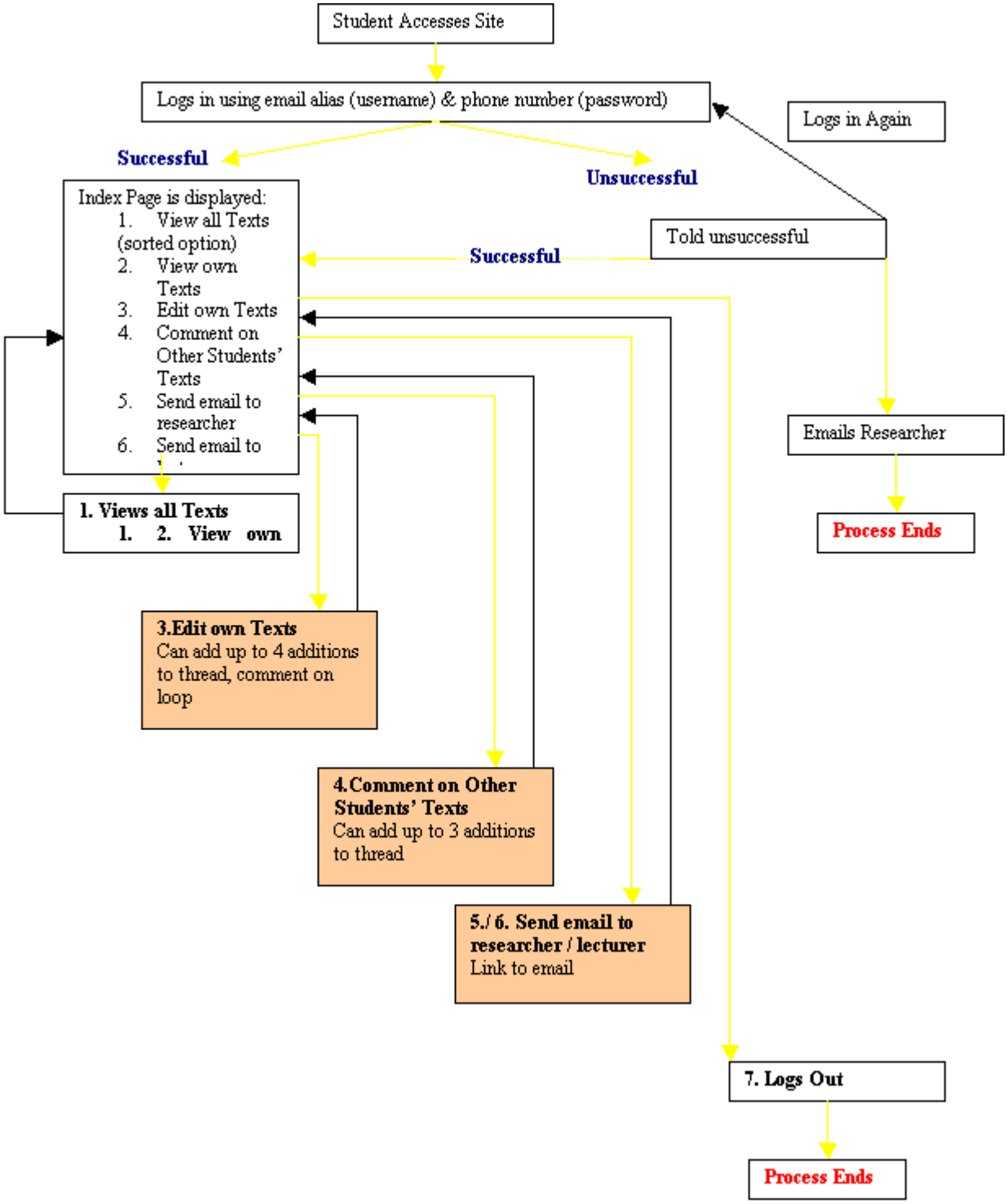
To view text log in Excel during class:

1. Open viewtexts.xls from 'C:/trinity'
2. The data will refresh itself from the text file every minute

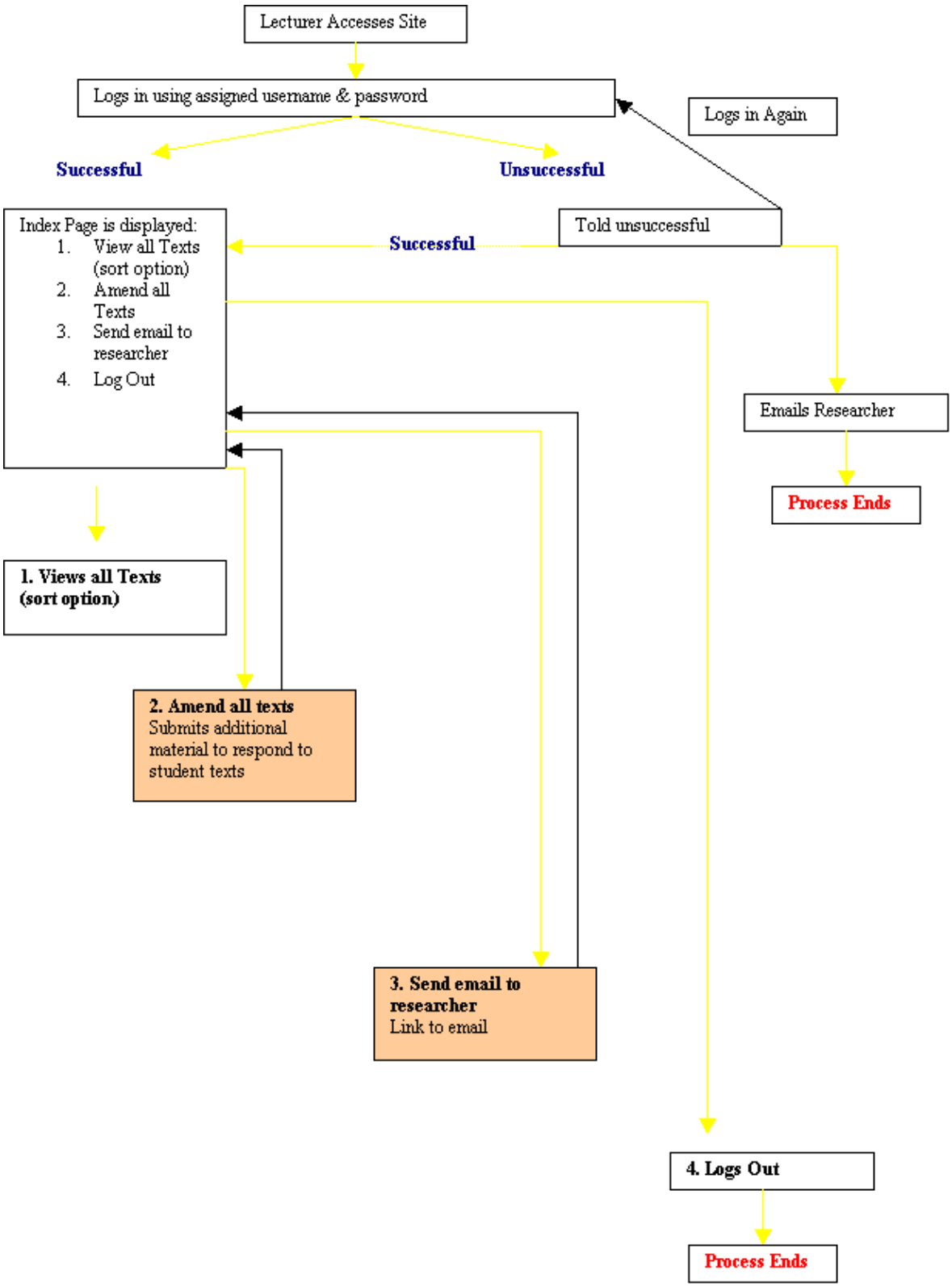
To stop accepting texts and finish project

1. Type the following in the DOS prompt
   Ctrl + C
2. Save the viewtexts Excel file and close Excel.

Appendix 3: Design: After Class Tool: Flowchart of Student Website Interface



Appendix 4: Design: After Class Tool: Flowchart of Lecturer Website Interface



Appendix 6: Design: After Class Tool: MySQL Database – Fields in Users Tables

users	Fields	Type	Source	Editable	Purpose
1	***userID (autoincrement)***	smallint(1), not null, autoincrement	MySQL	No	Primary Field
2	***fullname***	varchar(50), not null, full text	Sign Up	No	
3	***studentab***	varchar(10), not null, full text	Sign Up	No	
4	***username (email)***	varchar(16), not null, full text	Sign Up	No	
5	***password (phone)***	varchar(16), not null, full text	Sign Up	No	

Appendix 7: Design: After Class Tool: MySQL Database – Fields in Texts Tables

texts	Fields	Type	Source	Editable	Purpose
1	***dataid***	smallint(1), not null, autoincrement	MySQL	No	Primary Field
2	***userID***	smallint(1), not null	Upload	No	Attach message to original sender
3	***fullname***	varchar(50), not null, full text	Upload	No	Attach message to original sender
4	***studentab***	varchar(10), not null, full text	Upload	No	Attach message to original sender
5	***msg1***	varchar(170), not null, full text	Upload	No	Original Message
6	***msg1time***	time, not null	Upload	No	Original Message
7	***msg1class***	smallint(1), not null	Upload	No	Original Message
8	***msg2***	varchar(170), not null, full text	Upload / Web	Yes	In class message or using Web
9	***msg2time***	time, not null	Upload	n/a	In class message
10	***msg3***	varchar(170), not null, full text	Upload / Web	Yes	In class message or using Web
11	***msg3time***	time, not null	Upload	n/a	In class message
12	***msg4***	varchar(170), not null, full text	Upload / Web	Yes	In class message or using Web
13	***msg4time***	time, not null	Upload	n/a	In class message
14	***msg5***	varchar(170), not null, full text	Web	Yes	In class message or using Web
15	***msg5time***	time, not null	n/a	n/a	n/a
16	***loopcomplete***	varchar(16), not null, full text	Student Web	Yes	Using Web
17	***lec1***	varchar(170), not null, full text	Web	Yes	Using Web
18	***lec1time***	time, not null	n/a	n/a	n/a
19	***lec2***	varchar(170), not null, full text	Web	Yes	Using Web
20	***lec2time***	time, not null	n/a	n/a	n/a
21	***comm1***	varchar(170), not null, full text	Web	Yes	Using Web
22	***comm2***	varchar(170), not null, full text	Web	Yes	Using Web
23	***comm3***	varchar(170), not null, full text	Web	Yes	Using Web
24	***comm4***	varchar(170), not null, full text	Web	Yes	Using Web

Appendix 8: Design: After Class Tool: Website Design – Page Function and Links

Web page	Links	When
Index.php	login.html	No one is logged in
Index.php	logout.php	Logout
Index.php	readback.php	To read all students' texts
Index.php	readbackabstudent.php	Read all texts sorted by student
Index.php	vieweditEntries.php	Edit Your Texts
Index.php	viewEntries2.php	Read Your Texts
Index.php	vieweditEntriescomm.php	Comment on Other Students' Texts
login.html	login.php	Form action, posts login details
login.php	index.php	Index page for student when non-teacher logged in
login.php	login.php	When login fails (missing or incorrect data) creates form to re-link for login
login.php	teacher.php	Index page for teacher when teacher is logged in
logout.php	index.php	After logging out, allows user to log in again
teacherlogout.php	index.php	After logging out, allows user to log in again
readback.php	index.php	to try other options
readbackabstudent.php	index.php	to try other options
teacher.php	login.html	No one is logged in
teacher.php	readbackteacher.php	Allows teacher to view all students texts
teacher.php	readbackabteacher.php	Allows teacher to view all students texts sorted by student name
teacher.php	teacherlogout.php	Logout
teacher.php	teachervieweditEntries.php	Edit Students Texts
readbackteacher.php	teacher.php	to try other options
readbackteacherab.php	teacher.php	to try other options
viewEntries2.php	index.php	to try other options
vieweditEntries.php	editentry.php	php to update entries
vieweditEntries.php	index.php	to try other options
editentry.php	vieweditEntries.php	If no msg is found
editentry.php	updateentry.php	php to update entries
updateentry.php	index.php	to try other options
teachervieweditEntries.php	teacher.php	to try other options
teachervieweditEntries.php	teachereditEntry.php	the editing form

teachereditEntry.php	teacherviewEditEntries.php	If no msg is found
teachereditEntry.php	teacherupdateentry.php	php to update entries
teacherupdateentry.php	teacherviewEditEntries.php	If no msg is found
teacherupdateentry.php	teacher.php	Return to index
db.inc.php		Finds correct MySQL database
editEntrycomm.php	updateentrycomm.php	php to update entries
editEntrycomm.php	vieweditEntriescomm.php	If no msg is found
vieweditEntriescomm.php	editEntrycomm.php	to edit/comment on others
vieweditEntriescomm.php	index.php	to try other options
updateentrycomm.php	index.php	to try other options

Appendix 9: Design: After Class Tool: Data Display and Editing – Fields per Page

Web page	User	Viewable Fields	Editable Fields
editentry	Student	Alias, Original Message, Time, Class	Amend Message (up to 3 amendments), Loop Complete
editEntrycomm	Student	Alias, Original Message, Time, Class	Message Comment (up to 2 comments)
readback	Student	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
readbackabstudent	Student	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
viewEntries2	Student	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
vieweditEntries	Student	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
vieweditEntriescomm	Student	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
teachereditEntry	Teacher	Alias, Original Message, Time, Class	Message Comment (up to 2 comments)
readbackteacher	Teacher	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	
readbackteacherab	Teacher	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	

Web page	User	Viewable Fields	Editable Fields
teacherviewEditEntries	Teacher	Alias, Original Message, Time, Class, Message 2, Message 3, Message 4, Lecturer Comment 1, Lecturer Comment 2, Student Comment 1, Student Comment 2, Loop Complete	

Appendix 10: Methodology & Evaluation: Course Websites

Class A, Computers and Society (1BA6):

http://www.cs.tcd.ie/tangney/ComputersAndSociety/ShortDescription.html

Last accessed 22 February 2004

Class B, MSc. In Ubiquitous Computing

http://www.cs.tcd.ie/courses/mscubicom/

Last accessed 1 May 2004

Appendix 11: Methodology & Evaluation: Pre Questionnaire

1 Do you own a mobile phone? Yes / No

2 How frequently do you send SMS?
Rarely (less than 3 per week)
Occasionally (5-7 per week)
Frequently (2-3 per day)
Very Frequently (more than 3 per day)

3 Do you use SMS for academic purposes? Yes / No

4a *Do you ask the lecturer a question <u>in class?</u>*
Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a
4b *How satisfactory do you find this method of communication?*
1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

5a *Do you answer the lecturer's question <u>in class?</u>*
Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a
5b *How satisfactory do you find this method of communication?*
1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

6a *Do you address a fellow students' comments <u>in class?</u>*
Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a
6b *How satisfactory do you find this method of communication?*
1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

7a ***Do you answer a fellow students' question <u>in class?</u>***

Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a

7b ***How satisfactory do you find this method of communication?***

1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

8a ***Do you engage in an extended dialogue with the lecturer <u>in class</u>?***

Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a

8b ***How satisfactory do you find this method of communication?***

1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

9a ***Do you email the lecturer with a question <u>after class?</u>***

Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a

9b ***How satisfactory do you find this method of communication?***

1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

10a ***Do you arrange to meet with the lecturer <u>after class?</u>***

Never
Rarely (less than once per term)
Occasionally (2-3 times per term)
Frequently (once per class)
Very Frequently (more than once per class)

Do not complete if you answered 'never' in 4a

10b ***How satisfactory do you find this method of communication?***

1 (Not Satisfactory)
2 (Slightly Satisfactory)
3 (No Opinion)
4 (Satisfactory)
5 (Very Satisfactory)

Please rate your agreement to the following statements (11a-11c, 12) based on the scale below:

1 (Strongly disagree)
2 (Disagree)
3 (No opinion)
4 (Agree)
5 (Strongly agree)

11a ***I don't like public speaking***

11b ***I don't like fellow students knowing my questions/comments***

11c ***I don't like the lecturer knowing my questions/comments***

11d ***Additional comments***

12 ***The opportunities for participation in class are sufficient***

Thank you for completing this research questionnaire!

Appendix 12: Methodology & Evaluation: Post- Research Questions

1. Do you think the levels of interaction in the class were affected since the start of the project? (*please circle one*)

No No Opinion Yes

1a. If yes, can you elaborate on how class interactions increased?

2. Did the opportunity to send SMS affect your interactions in class? (*please circle one*)

No Effect No Opinion Yes (Effect)

2a. If yes, can you elaborate on how your interactions in class were affected?

3. Did you send an SMS in class? (*please circle one*)

No Yes

3a. If you answered ***no*** above, can you identify why you didn't send an SMS?

3b. If ***yes***, please answer the following questions:

3c. Did the lecturer reference your SMS during class? (*please circle one*)

No No Opinion Yes

3d. Do you feel the lecturer fully responded to your SMS ***in class***? (*please circle one*)

No No Opinion Yes

3e. Do you feel the lecturer fully responded to your SMS ***after class***? (*please circle one*)

No No Opinion Yes

3f. How satisfactory did you find this method of communication? (*please circle one*)

1 (Not Satisfactory)	2 (Slightly Satisfactory)	3 (No Opinion)	4 (Satisfactory)	5 (Very Satisfactory)

3g. Did you find any barriers to writing the SMS during class? (*please circle one*)

- No
- No Opinion
- Yes (*please specify why, i.e. time consuming, distracting*)

4. Did you access the website (containing class SMS) after class? (*please circle one*)

No Yes

4a. If ***yes***, did the website help your understanding of the concepts / material covered in-class? (*please circle one*)

No Yes

4b. If you answered ***no*** above, can you identify why you didn't access the website?

5. For what size / style of classes do you think texting in class is appropriate? *(please select all that apply)*

- Large Lectures
- Small Tutorials
- Labs
- Not appropriate in any classes
- Other *(please specify)*

6. For what type of class activities do you think the SMS interface is appropriate? *(please select all that apply)*

- Lectures
- Single Student Presentations
- Group Presentations
- Debates
- Guest Speakers
- Not appropriate in any class activities
- Other *(please specify)*

7. Would you like to have the opportunity to send SMS in future classes? *(please circle one)*

No No Opinion Yes

7a. If ***no***, why not? *(please select all that apply)*

- Cost of sending SMS
- My mobile is for personal use
- Distracting during class
- Does not add to learning
- Not interested in participating in class
- Other (*please explain*)

7b. If ***yes***, what changes would you make? *(please select all that apply)*

- Free SMS
- Show SMS to all students during class
- Require students to send SMS
- Use the website more after class
- Don't use the website
- None
- Other (*please explain*)

8. Did you have your mobile with you during class? *(please circle one)*

No Yes

8a. If ***yes***, please answer the following questions:

8b. Was your mobile on? *(please circle one)*
No Yes

8c. Did you send SMS to classmates during class? *(please circle one)*
No Yes

8d. Did you send SMS to numbers outside of class, during class? *(please circle one)*
No Yes

8e. Did you read received SMS? *(please circle one)*
No Yes

Would you be available for an interview with the researcher, or to answer more questions via email?

- Yes, please contact me by phone
- Yes, please contact me by email
- No

Thank you for your participation in this research project!

Appendix 13: Methodology & Evaluation: Post-Research Questions for Presenters

If you presented in class, please answer the following questions in relation to your experience while your group presented:

9. Did you find the interface for viewing received texts easy to follow? (*please circle one*)

No Yes

10. Received texts were displayed with message & time. What other information would you like to see? (*please select all that apply*)

- Sender's Name (real)
- Sender's Alias (i.e. StudentA, StudentB)
- Other (*please specify*)

11. What sorting would you prefer? (*please circle one*)

- Time SMS sent
- Student sender
- Other (*please specify*)

12. While presenting, did you find audience members using their mobiles distracting? (*please circle one*)

No Yes

13. While presenting, did you find the SMS viewing interface distracting? (*please circle one*)

No Yes

14. Would you use the SMS interface for future presentations? (*please circle one*)

No Yes

14a. If no, why not? (*select all that apply*)

- Distracting during class
- Does not add to learning
- Other (*please explain*)

14b. If yes, what changes would you make? (*select all that apply*)

- Show SMS to all students during class
- Require students to send SMS
- Use the website more after class
- Don't use the website
- None
- Other (please explain)

Appendix 14: Methodology & Evaluation: Post-Research Questions for Lecturers

1. Can you describe the class interactions (during your lectures) prior to using the SMS interface?

2. What made you interested in using the SMS interface?

3. How did you think the SMS interface would affect class interactions?

4. Can you describe the class interactions when the SMS interface was used this past week?

5. What surprised you (if anything) about the actual implementation of the SMS interface?

6. Have students discussed the SMS interface with you? If so, can you summarise the discussion?

7. Would you use the SMS interface for future lectures?

8. What changes would you suggest for any future implementations?

9. Why did you want to videotape the class following the first session? (only lecturer for Class A)

10. Would you use the SMS interface for future student presentations? (only lecturer for Class B)

11. Please tick the types of classes or class activities for which you think the SMS interface may be appropriate:

    - ☐ Large Lectures
    - ☐ Small Tutorials
    - ☐ Labs
    - ☐ Single Student Presentations
    - ☐ Group Presentations
    - ☐ Debates
    - ☐ Guest Speakers
    - ☐ Not appropriate in any class activities
    - ☐ Other *(please specify)*