Assessment Using Mobile Phone - An Exploratory Study

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Abstract

An assessment task typically comprises a stimulus posed by the assessor with the purpose of eliciting a response from the examinee. Traditionally, both stimulus and response are written on paper. More recently, non-print platforms such as computers have been used in presenting the stimulus and response. The increasing use of mobile communication devices such as mobile phones and PDAs has now prompted studies on the use of these mobile devices in assessment. The use of mobile phones has increased tremendously in the past decade in Singapore and around the world. Hence, it is timely to conduct an exploratory study to gain first-hand knowledge on the use of this medium in assessment. The study aims to determine factors to consider in designing an assessment system using mobile phone and find out if it is technically feasible. A prototype was developed and an internal trial conducted. The paper reports on the findings of the trial, flashes out problems encountered and discusses potential gains and shortfalls of such a system.

Introduction

An assessment task typically comprises a stimulus posed by the assessor with the purpose of eliciting a response from the examinee. Traditionally, both stimulus and response are written on paper. More recently, non-print platforms such as computers have been used in presenting the stimulus and response. The increasing use of mobile communication devices such as mobile phones and PDAs has now prompted studies on the use of these mobile devices in assessment.

The possibilities associated with mobile devices (phones, PDAs) in learning and assessment can be demonstrated by the following few studies. Thornton *et al.* [1] conducted a study on university students in Japan. Their poll shows that almost all students email on mobile phones but less than half email on personal computers. An even smaller proportion of students own PDAs. Their study involving emailing students 100-word English vocabulary lessons regularly to students shows that students receiving mobile email learnt more than those receiving identical materials on paper or the internet. The majority of the students preferred receiving these lessons on mobile phones rather than personal computers. Most students also regarded mobile phone as a valuable teaching method. Aside from emailing students vocabulary lessons, Thornton *et al.* also included a trial on accessing web site explaining English idioms using video-capable phones. Even though the explanation involves multimedia such as animation, video clips and text finding, the students encountered few technical difficulties and rated the approach highly.

To contextualize learning, Chen *et al.* [2] created a mobile system using PDAs and a mobile server to scaffold students' learning about bird watching. The system harnesses the strengths of mobile learning environment including interactivity to cater to individual needs and foster interaction between the expert and the learner for bird watching. Based on their formative evaluation, students who used the system improved their learning compared to those assisted by traditional guidebook.

In their paper, Relan *et al.* [3] examines the use of PDAs as an integral component of the clinical curriculum (clerkships) at a leading US based medical school. PDAs are used by students to access pharmacopoeia and knowledge-based tools, and to capture data for patients. A survey of students revealed that pharmacopoeia and knowledge-based tools were considered useful by students as they addressed knowledge gaps and provided instant response to students' queries. On the use of patients' data logged by students, it was observed that while the technology was in place to gather data, most members of the clinical faculty were not using the data to scaffold student learning.

His's [4] study involves enhancing users' experience in a museum using nomadic web content delivered using a clamshell pocket computer (HP Jordana 548). The author noted that while mobile devices may introduce new activities and new ways of interactions in a museum, users also found the experience to be socially isolating.

In teacher training, Seppala *et al.* [5] makes use of mobile devices (phones and digital cameras) to allow supervising teachers and trainee teachers to share and discuss teaching ideas. Short message service (SMS) and digital pictures could be uploaded to a central server accessible by all. The study noted considerable amount of exchanges amongst the participants, especially in digital pictures.

Motivation for Study

Over the years, mobile phone subscribers in Singapore have increased tremendously to 978 per 1000 population in 2005[1]. This means that nearly everyone in Singapore owns a mobile phone. It is timely to start accumulating first-hand knowledge of what mobile phone can offer in the area of assessment. NCS Pte. Ltd. and Singapore Examination and Assessment Board (SEAB) conducted an exploratory study to determine the technical feasibility of using mobile phones in assessment. The study also aims to uncover assessment issues in using mobile phone for assessment. A prototype was developed and an internal trial involving staff with teaching and assessment experiences was conducted. Though these staff members were not involved in the development process, their perspectives would be valuable in evaluating the use of this medium in assessment. In summary, the study aims to find answers to the following questions about assessment using mobile phone:

(a) What are the factors to consider in designing the system?
(b) Is the idea of using mobile phone to conduct assessment technically feasible?
(c) What are the problems and potential gains?

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Design Considerations

The design of the prototype should take into consideration the needs of the users and the characteristics of mobile phones, as noted by Grasso *et al*. [6]. He commented that such a system should be directed towards achieving some learning goals and opined that the way information is presented is a determinant in the effectiveness of assessment using mobile phone. This in turn is constrained by features of the mobile phone like the screen size and level of interaction allowed. He also pointed out that while multimedia could improve the quality of learning systems, it does not always enhance learning, and may even distract users from the intended learning goals. Because of their smaller size, mobile devices reduce the array of presentation possibilities. Finally, he commented that some adaptation functions could be incorporated in the design to cater to the needs of individuals.

Several key considerations were identified in the design of our prototype. First, the system is more likely to be successful if it adds value to both students and teachers. Hence, both teachers and students are defined as users and the system should offer them some advantages over the traditional pen-and-paper test. As our first endeavor, we decided to build a prototype that will allow students to take a quiz using the mobile phone and provide them with instant feedback. The system will also allow teachers to know students' responses to every item. Instant feedback will make students' learning more efficient as there is no time lag between their responses and feedback. Teachers will welcome the fact that the system could automatically score and keep track of each student's progress. This will ease their marking workload. Moreover, they are able to gather item level data to understand strengths and weaknesses of their students and refine their teaching and item writing skills.

The second consideration relates to the characteristics of the mobile phone. The contents for the mobile phone must be significantly reduced in conformity with the limited capacity of the device. A reduced content will also make the system more responsive. The small screen size of mobile phones suggests that short quiz items will be more palatable as it reduces the amount of scrolling to see the entire item. Excessive scrolling to see the entire item and options should also be avoided.

These considerations led us to consider language quizzes targeted at upper primary students (Grades 4-6) as smaller bits of content can be presented on the screen. In addition, language testing usually does not involve graphics or symbols, which will reduce transmission load over the air. Primary level is selected as assessment for other levels tended to involve more content, which would make it harder to deliver using mobile phones.

The next thing to consider is the types of assessment items that we could use in the quiz. While it is possible to ask students to key in short responses, it was felt that a simple multiple-choice quiz could serve as the first step. As a large part of assessment in school is not contextualized, a quiz that models after the usual kinds of assessment may attract more support from teachers and students.

The number of items on the quiz should not be too many. This medium is intended to be used anywhere and is subjected to distractions from the environment. Students could use it on a train or while waiting. It may be less likely for students to use the phone for assessment at home as their personal computers is faster with a bigger screen. In addition, the small screen size and resolution of mobile phones may tire students out easily. Hence, a quiz of not more than 15 items for the prototype was used as it provides enough items to practice on a particular language content or skill.

It was also intentional to keep the quiz less media intensive as downloading cost associated with media intensive materials could be higher than text-based materials. Moreover, having more media will make the system less responsive.

English Grammar Quiz Using Mobile Phone

The quiz consisted of 15 discrete multiple-choice items on English Language. The quiz was pitched at a level that is appropriate to primary six students (typically twelve-year olds) in Singapore. The items were designed to allow students to demonstrate their understanding of the correct use of grammar, particularly in the areas of concord and tenses. In each item, a verb or verb phrase was deleted, and the students are required to choose the correct verb or verb phrase that best fits the given context from a choice of four options. Each item typically consists of a single sentence, although this sentence may be of different structural types, as demonstrated by the five examples below:

Q1 When Ali was living in Bishan, he _____ soccer in the nearby park during the weekends.
1) plays
2) played
3) will play
4) has played

Q3 "Neither Mary nor Salimah _____ the qualifications for this job," the manager told his secretary after looking through their job applications.
1) has
2) have
3) had
4) having

Q5 If the bus _____ into the river, the passengers would have drowned.
1) fell
2) fall
3) has fallen
4) had fallen

Q13 "You have forgotten to wash the clothes, _____ ?" Mdm Devi asked her daughter
1) isn't it
2) wasn't it
3) didn't you
4) haven't you

Q15 As it _____ heavily for thirty minutes, the referee had no choice but to stop the soccer game.
1) rains
2) is raining
3) was raining
4) has rained

Technical Description of the System

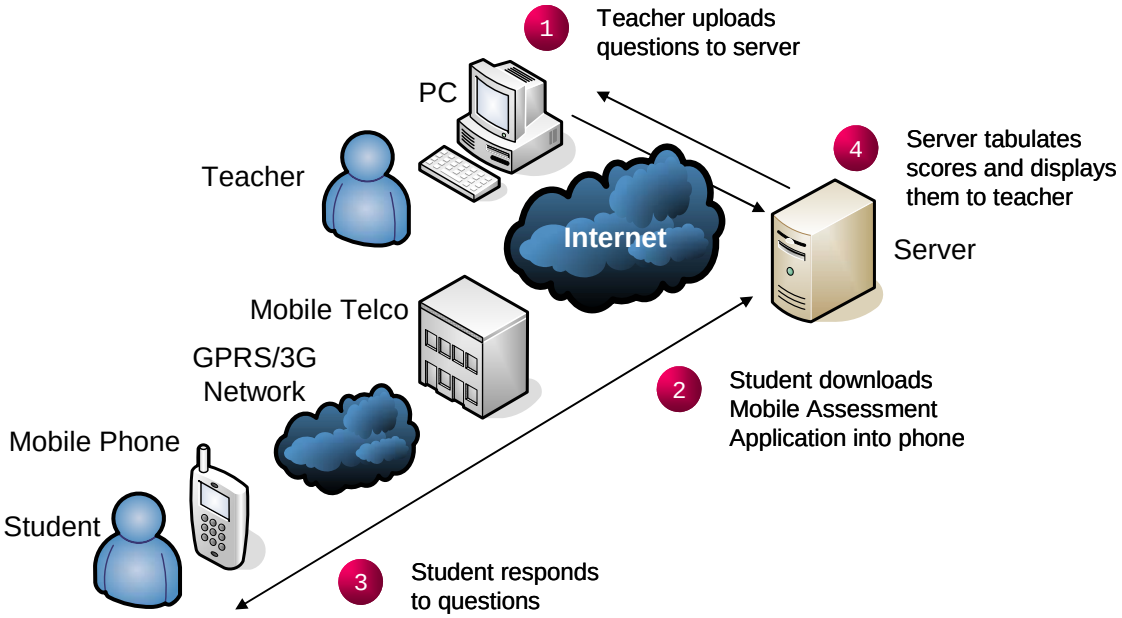
The mobile assessment system was custom-developed by NCS Pte. Ltd. Three mobile technologies were evaluated for use in this trial:

- **SMS (Short Messaging Service)**: The questions could be sent to students via SMS messages, after which the students could reply with the answers via SMS messages. This approach is susceptible to delays because delivery times of SMS messages may vary greatly. When responding to a stream of questions, there is possibility of the SMS messages being duplicated or delivered out of sequence, causing errors in scoring.

- **WAP (Wireless Application Protocol)**: The questions could be displayed in the student's mobile phone as a very simple Internet web page based on the WAP format. The student could then select the response using the mobile phone's navigation keys. The questions and answers would be transmitted using GPRS (General Packet Radio Service) or 3G (3rd Generation) mobile data networks. However WAP generally offers an unfriendly user interface that may be confusing to students. When the mobile data transmission breaks due to network issues, it is not possible to recover from the error and show the student a helpful message.

- **J2ME (Java 2 Micro Edition)**: The student could download and install a small J2ME application that would interact with the server over the GPRS and 3G mobile data networks, fetching questions and transmitting responses. Unlike WAP, J2ME applications have full control over the mobile phone screen to ensure that the application looks and operates the same on any mobile phone. J2ME applications also have full control over the data transmission and can retransmit the data in case of errors. The J2ME approach was chosen due to its superior reliability and ease of use.

The following diagram describes the flow of the mobile assessment system:



(1) The teacher prepares the questions and answers in a Microsoft Excel spreadsheet template that is provided. When the teacher activates an Excel macro, the questions and answers are converted into program code that is uploaded to the Server over the Internet.

(2) To begin the assessment, the student keys in an Internet address into his/her mobile phone to download and install the Mobile Assessment Application developed in J2ME. The application is transmitted over the Internet via the mobile telecommunications operator and the GPRS or 3G networks into the student's mobile phone. The application only needs to be downloaded once.

(3) The student activates the Mobile Assessment Application on his/her mobile phone. The application fetches the questions from the Server and displays them to the student. The student selects the answers and his/her responses are transmitted to the Server over the mobile data network.

(4) The Server consolidates the responses and displays the scores through an Internet web page that may be viewed by the teacher.

The following shows sample screens from the Mobile Assessment Application:

In Singapore, the GPRS data charge for downloading the Mobile Assessment Application (25 KB in size) is approximately USD 8 cents. The GPRS data charge to cover the transmission of questions and responses for a 15-question quiz is approximately USD 5 cents.

Findings of the Trial

An internal trial followed by a survey was conducted to evaluate the prototype, involving professionals with experiences in both teaching and assessment. The survey covered areas like *Ease of Use*, *Satisfaction and Value* and length of quiz. They were also asked for aspects of the system that they like or dislike. Finally, their opinions on whether they would recommend taking quizzes on mobile phones to upper primary students were sought. The findings are presented below.

Ease of Use

The initial downloading of the application into the cell phone was problematic because most users currently do not use cell phone to access the internet. Depending on the model of the cell phone, the steps to set up access for downloading could be different. After a few failed attempts initially, we decided to download the application into a mobile phone and let participants use the phone for the trial. It would have been ideal for each to use their own phone but the downloading process was an obstacle for trailing in view of the fact that most users do not use their phone to access the internet currently. Hence, the findings should be interpreted in the light of the set-up for the trial.

Of the 15 participants involved in the trial, nearly all (93%) felt that the phone was slow in responding and a large majority (87%) felt that the screen size was too small. Most (73%) also felt that the questions were difficult to read on screen. All (100%) thought that following the on-screen instructions was easy. They also felt that it was easy to use the phone for the quiz (73%) and most did not need much/any help in using the phone of the quiz (80%). However, this last finding should be interpreted in the light of the set-up for the trail, as the participants did not experience the complexity involved in the one-time downloading of the application and connecting to the internet. Nonetheless, this was a one-time effort, which was not featured in the trial.

Satisfaction and Value

A large majority of participants (93%) found the instant feedback to responses was useful and opined that it was a valuable teaching tool (80%). However, in spite of being a novelty, most (60%) participants did not enjoy taking the quiz on the phone and did not perceive it to be fun. Two-thirds preferred the conventional pen-and-paper test, rather than the quiz on mobile phone.

About two-thirds felt that the number of items was just right though a few felt that there were too many questions, perhaps influenced by the slow response of the phone.

Likes and Dislikes

When asked about what they liked about the phone, most participants liked the instant feedback to responses. A participant commented:

"[I like] the instant feedback when you get the answers wrong. Instant feedback

helps to reinforce learning, something which pen-and-paper test lacks. May be a good tool for formative learning as the kids play with hand phone all the time"

The fact that assessment could now take place anytime and anywhere also appealed to a few. A participant commented:

"It is an "in" thing, quite fun and handy. Students need not carry test paper and stationery with them. The quiz can be carried out anytime and anywhere. Small children find it exciting."

The novelty effect of the system was also echoed by some participants**.**

On dislikes about the system, a large majority highlighted the slow response of the system, especially in between items. Participants had to wait for about 5 seconds in between items. The screen of the phone also flashed in between items as the phone downloads the item, which seemed confusing. About half of the participants also noted that they disliked the excessive scrolling to see the entire item and the small screen size. A participant commented:

"Several questions position the blank [i.e. the selection bar] near the beginning of the question. I had to remember the question or the response, scroll down to match the response and this is time consuming and confusing.

Other dislikes mentioned included application error during the quiz, which required them to start the quiz all over again. The fact that they could not change or review their answers once they send in their responses was also mentioned.

Recommendations

Participants were given additional information on the fact that teachers were able to know students' responses to every item. The cost of the quiz they had completed (approximately US$0.12) was also made known. Having tried the quiz and armed with this additional information, only two would definitely recommend taking quizzes on mobile phones to primary students. Another two would recommend its use "*if these students have lots of time and patience and no butter fingers*" or "*if the limitations listed (i.e. slow response and small screen size) are rectified and subsidy for poor students is available*". Among those who did not favor the medium, most cited cost as reason. A few also said that a computer could do a better job. Some comments were:

"No. Because this only applies to MCQ and cannot be generalised to other quiz formats where we might wish to assess the thinking process involved. What's more, 20 cents [US$0.12] per quiz may be a substantial sum of money for primary school kids to fork out (if this becomes a regular thing) if they happen to belong to the low income group"

"Students can use computers in the school or at home to take a similar quiz to achieve the same benefits, yet without the disadvantages. However, this will be a good idea for older students or for other survey purposes."

Other reasons cited for not recommending the use of the phone included issues like

students without a phone, the small screen size and slow response of the phone.

Other Observations

There were several other observations worthy of mentioning here. A participant noted that navigating using the button on the mobile phone was difficult. When scrolling down, too much pressure would result in sending the response when not intended. Another participant commented that perhaps in the near future, one could use voice activation/response instead of keypad, which was rather difficult. A participant observed that when the words for option were too long, they were truncated. There is a need to cater to large and small screen of phones in designing the way items are shown on the screen, as different users may have different models of mobile phones.

Several participants had to start the quiz all over or did not finish the entire quiz due to the unstable nature of the network or participant hitting the wrong key. This is a significant problem if high stake tests are delivered using mobile phone.

There was no technical problem in terms of seeing participants' responses real-time using the internet. Figure 1 below shows what a teacher will potentially see. A refresh of screen would let teachers know instantly how many items each student has completed. One possible refinement to the system would be to include start time and the time students take to complete the quiz. This could serve as an indicator of the strength of students in the subject. Other possible enhancements include features to compute item and test statistics, which could be useful feedback for teachers to enhance their item writing skills.

Figure 1: Screen capture of real-time responses of participants available on the internet

	User	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10	Q 11	Q 12	Q 13	Q 14	Q 15	Qns Attempted	Qns Correct	Qns Incorrect	% Correct	Last Modified
1	adt	✓	✓	✓	✓	✓	(2)	✓	(3)	✓	✓	✓	✓	✓	(4)	✓	15	12	3	80%	13/03/06 2:40:16pm
2	bn	✓	✓	✓	✓	✓	(2)	(3)	(1)	(1)	(2)	✓	(1)	✓	✓	✓	15	9	6	60%	06/03/06 5:23:55pm
3	chk	✓	✓	✓	✓	(1)	(3)	✓	(3)	✓	✓	(1)	✓	✓	✓	✓	15	11	4	73%	13/03/06 4:59:11pm
4	ct	✓	(1)	✓	✓	✓	(1)	✓	✓	✓	✓	✓	✓	✓	(4)	✓	15	12	3	80%	13/03/06 4:30:52pm
5	eh	✓	✓														2	2	0		07/03/06 4:04:43pm
6	es	✓	✓	✓	(1)	✓	(2)	✓	✓	✓	✓	✓	✓	✓	✓	(4)	15	12	3	80%	10/03/06 3:51:01pm
7	ga	✓	✓	(2)	(4)	✓	✓	✓	✓	✓	✓	(2)	✓	✓	✓	✓	15	12	3	80%	13/03/06 3:52:50pm
8	kb	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	(2)	✓	✓	✓	✓	15	14	1	93%	13/03/06 5:24:51pm
9	kw	(1)	✓	(2)	(1)	✓	✓	✓									7	4	3		13/03/06 8:50:36am
10	lyu	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	15	15	0	100%	07/03/06 9:18:28am
11	mn	✓	✓	✓	✓	✓	✓	✓	✓	✓	(1)	✓	(4)	✓	✓	✓	15	13	2	87%	09/03/06 10:28:50am

Summary of Findings

Our first prototype and trial on mobile assessment has led us to the following key observations.

The ability to capture students' responses real time opens up many possibilities for teachers. It could ease the marking workload of teachers and facilitate monitoring of students' performance down to item level. It also allows for the easy computation of item and test statistics, which may be more time consuming if traditional pen-and-paper medium is used for assessment. This information could be used to hone teachers' item writing skills. For testing and survey agencies, this medium could be used to collect data on items or survey questions. From the perspective of students, the instant feedback will make learning more efficient. Students can also learn anytime and anywhere. Having said that, it should be noted that the computer offers the same advantages. The edge that mobile phone has over computer or laptop is its portability.

There are limitations in using mobile phone in assessment. Slow response speed and small screen size will limit the kinds of content that can be used. Items that require lengthy open-ended responses may not be tenable, though short responses are possible, as more students get accustomed to text messaging. Unpredictable application errors make it difficult to use this medium for high-stake examinations. The medium may be more useful in a formative assessment setting. Nonetheless, in a controlled classroom environment, there is scope for its use for summative assessment purposes. Finally, the cost of using such a medium in a school setting will be an issue to contend with.

One way to counter the existing slow response rate and cost involved in having too much content transmitted over the air is to use a combination of media. For instance, one could use mobile phone to capture responses while items could continue to be printed on paper. However, this will not capitalize on the ubiquitous nature of mobile phone in assessment.

Concluding Remarks

This exploratory study involving an internal trial has flashed out many technical and assessment issues associated with assessment using mobile phone. In spite of attempts to have smaller content and shorter items in the design phase of the prototype, many shortfalls still prevail. These shortfalls will need to be addressed for mobile phone to be practical and useful as a medium for assessment.

References

1. Patricia Thornton, Chris Houser, *Using Mobile Phones in Education,* Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04).

2. Y, S. Chen, T. C.. Kao, and J P, Sheu, *A Mobile Learning System for Scaffolding Bird Watching Learning*, Journal of Computer Assisted Learning, 19, 2003, pg. 347-359.

3. Anju Relan, Neil Parker, Soma Wau, Gretchen Guiton, Cha Chi Fung, *Supporting Handheld Technologies in a Medical School Curriculum: Lessons from Three Years of Design, Development and Implementation*, Proceedings of the The 2"d IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04).

4. S. His, *A study of user experiences mediated by nomadic web content in a museum*, Journal of Computer Assisted Leaming (2003) 19, pg. 308-319.

5. P. Seppala & H. Alamaki, *Mobile learning in teacher training*, Journal of Computer Assisted Learning (2003) 19, pg. 330-335.

6. Antonella Grasso, Teresa Roselli, *Guidelines for Designing and Developing Contents for Mobile Learning*, Proceedings of the 2005 IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'05).