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Towards Designing m-Learning Systems for Maximal Likelihood of Acceptance*

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So far, in the field of m-learning the issue of technology acceptance has been largely overlooked. We apply the Technology Acceptance Model to consider the requirements for a generic m-learning system that would maximize the likelihood of its acceptance, and conclude that such a system should rely on the existing infrastructure and mobile device ownership. We back this conclusion by conducting a survey on m-learning acceptance targeted at educators and by developing a system prototype and evaluating it in a simulated classroom environment. The results speak in favour of introducing low cost, low maintenance m-learning systems targeting average, budget conscious educational institutions, with SMS technology being the most appropriate technology under present conditions.

Keywords: technology acceptance; mobile learning

INTRODUCTION

FOR AN INFORMATION SYSTEM to make a positive economic, societal or educational impact, it is essential that it is accepted by its users. Research in technology acceptance remains a particularly important topic in information systems research for a number of years [1, 2]. Since in educational institutions (particularly, in higher education) students and teachers normally enjoy greater freedom then company employees, for a system enabling technology-assisted learning the acceptance factor can be argued to be even more crucial for success than in the case of information systems serving businesses, and forms a separate topic of research [3, 4].

On the other hand, so far, in the field of m-learning the issue of technology acceptance has been largely overlooked. Indeed, one could argue that most of the existing work on creating systems for m-learning concentrates either on applying advanced technology to support very narrowly defined educational objectives [5, 6], or on wide-ranging, highly expensive systems that require high technical expertise to support them [7, 8]. It is easy to see that both categories of systems are likely to have acceptance issues: achieving narrow educational goals may not be seen as enough of a benefit to justify learning the technology (in particular, by the teachers), while wide-ranging systems effectively introducing a new layer of technology infrastructure can be regarded as too expensive and difficult to support (even though they are designed to meet a wide range of educational goals). However, so far, there was no research that would consider the problem of acceptance of m-learning technology in general by prospective users (namely, teachers and students), and would make recommendations for system design based on acceptance considerations.

M-LEARNING ACCEPTANCE BY EDUCATORS AND EDUCATIONAL INSTITUTIONS

To consider the requirements for systems that would address the problems with m-learning acceptance, we conducted a survey by distributing a questionnaire among teaching staff of a big university in New Zealand. The participants were involved in teaching in positions that enabled them to have a say in what sort of technology is used in the teaching process (senior tutors, lecturers at different levels and associate professors). All of them taught papers in Information Systems and Computer Science, and thus by the virtue of their background, either had some understanding of m-learning, or could be taught the basics very easily. The survey form consisted of two parts: the first part asked participants to rate various potential uses of m-learning, as claimed in the literature, such as [9] and other papers in the proceedings volume it introduces, while the second part rated various potential problems (or perceived potential problems).

When compiling the potential problems, we took into account the existing literature on problems in adapting e-learning in general [10], and added some potential problems that are specific to using mobile devices. The survey questions and the aggregate results (based on 11 responses) are given in Tables 1 and 2.

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Table 1. m-Learning acceptance survey, part 1. In this part, the participants were asked to 'rate the benefits/capabilities associated with using mobile devices in learning and teaching (m-learning)', on a scale from 1 to 6, where 1 stood for 'this is not really a benefit', and 6 stood for 'this is an important benefit'

No	Question	Mean	Std. dev.
1	Delivering prepared content to students ('push' model). Ensuring that the content reaches them any time, where they are	4	1.73
2	Enabling students to search for content relevant to problem solving / project work	4.55	1.44
3	Class administration (notification of deadlines, assignment results, news items etc.)	4.73	1.01
4	Receiving instant feedback on the quality of teaching (e.g. rating a lecture as it progresses)	2.82	1.33
5	Administering on-line quizzes in controlled (classroom) and in uncontrolled environments	3.82	1.25
6	Facilitating collaboration between students (e.g. when working on projects in groups)	4.46	1.13
7	Facilitating communication between the teacher and the students (e.g. guidance and scaffolding during students' work on assignments).	4.18	1.54
8	Imposing flexible time and space constraints (e.g. to encourage lecture and tutorial attendance)	3.27	1.62
9	Facilitation of note-taking and word processing (e.g. allowing students to work anywhere on campus, in cafes, in the library etc.)	4.64	1.21
10	Creating competitive environments, in which students compete against each other for best results	2.55	1.29
11	Delivering content in context (e.g. information about a location as students approach the location during a field trip)	4.18	1.60

This survey design was inspired by the Technology Acceptance Model, which states that perceived usefulness (perceived potential uses leading to increased effectiveness and efficiency) and perceived ease of use (absence of problems in using a new technology/system) act as primary factors directly determining the eventual acceptance and adoption [1, 8]. TAM is not the only theory attempting to explain and predict technology acceptance: a comprehensive overview of competing approaches is given in [12], which makes an attempt to synthesize all prominent approaches into a unified approach and validates the resulting Unified Theory of Acceptance and Use of Technology (UTAUT) by using a large-scale longitudinal study of technology acceptance in four organizations. UTAUT adds to perceived usefulness and perceived ease of use two more major factors directly influencing acceptance: social influence (cultural or direct pressure from peers and superiors to use the new technology) and facilitating conditions (organizational support in using the new technology, such as the availability of technical support). As in case of m-learning the technology is at early stages, and is not at all used at organizations to which our subjects belong, neither social influence nor facilitating conditions have taken shape, which leaves us with the basic TAM model.

From Table 1, which outlines the results of the first part of the survey we can see that the top three benefits are viewed as facilitation of class administration, the use of mobile devices for note-taking and word processing, and enabling students to search for content relevant to problem solving. Facilitation of collaboration between students comes as a close fourth. We observe that, to a degree, all of these benefits can be achieved by using the mobile network infrastructure 'as is', without using any dedicated system on top of the mobile network.

The least popular benefits related to creating competitive environments and to receiving instant feedback on the quality of teaching.

Respondents were at most in disagreement over the benefits of providing content over mobile devices, imposing flexible time and space constraints to ensure lecture attendance and delivering content in context. We note that while these were not the most widely recognized benefits, for both, there were respondents who rated them very high, which in combination with high standard deviation indicates that there could be a well defined group of educators for whom these benefits are important.

The data in Table 2, covering the second part of the survey, demonstrate that the perceived problems considered to be most significant (clearly ahead of the rest) are costs of mobile devices and of the supporting infrastructure, and the possibility that the introduction of m-learning would increase teacher load. Also, we have to observe that the necessity for teachers to learn how to use mobile devices, and the necessity to manage physical mobile devices took the fourth and the fifth place in being perceived as obstacles.

We conclude that the results of the survey suggest that rather than focusing on advanced technical capabilities, to maximize the possibility of acceptance m-learning should focus on relying on technologies for which the infrastructure is already available. In particular, in case of using SMS messaging in New Zealand and at similar locations, the infrastructure is already in place, and most students already own SMS-capable devices (hence, there is no additional expense and educational institutions do not need to manage them), so that some of the most significant obstacles to adoption are removed. This conclusion is further supported by one of the outcomes of comparison of factors determining the use of ordinary web sites and wireless sites conducted in [12]: in case of wireless devices direct access to relevant information and functionality is paramount, while richness of multimedia experience (provided by more sophisticated devices and services) is less important.

Table 2. m-learning acceptance survey, part 2. In this part, the participants were asked to 'rate the potential problems associated with using mobile devices in learning and teaching (m-learning)', on a scale from 1 to 6, where 1 stood for 'this problem does not exist', and 6 stood for 'this is a significant problem'

No	Question	Mean	Std. dev.
1	The risks associated with adopting m-learning are too high, while the benefits are uncertain	3.27	0.47
2	High costs of mobile devices and of the associated infrastructure are probably difficult to justify by the potential benefits	4.27	1.68
3	The introduction of m-learning would increase teacher workload	4.45	0.93
4	Learning to use mobile devices and the associated support infrastructure would take too much teacher time, which could be used elsewhere with greater effect	3.55	1.21
5	Learning to use mobile devices would take too much learner time, and would distract learner from learning the actual subject matter of the course	3.10	1.14
6	Since the existing study materials cannot be used for m-learning without significant adaptation, the introduction of m-learning would lead to the loss of investment made in the existing study materials	3.27	1.42
7	Managing (e.g. lending out) the physical mobile devices, and dealing with incidents of loss, larceny etc. would prove to be too expensive and time-consuming	3.55	1.69
8	Since not all students can afford devices of the same quality, it would lead to inequality and potential discontent among students	5.00	1.67

In addition, it appears to be beneficial to offer the ability for teachers to manage m-learning via familiar interfaces, such as HTML forms (so that teachers do not need to deal with mobile devices directly).

While the problem of not being able to reuse existing content did not rate very high, we would argue that if the possibility of reusing content were clearly demonstrated it could alleviate some of the perceived problem of higher teacher load associated with m-learning.

PROTOTYPE IMPLEMENTATION OF AN SMS-BASED SYSTEM FOR PERVASIVE TESTING

To gauge if an m-learning system based on SMS messaging technology (the m-learning capable mobile technology for which the infrastructure is universally available) would be accepted by students, we conducted an evaluation of a system prototype.

The prototype system we implemented allowed students to answer quizzes by sending SMS messages in predefined format. Quizzes were delivered as PowerPoint slides, thus allowing for easy integration with existing material. The prototype supported the four most common on-line question types (multiple choice—choose one, multiple response—choose one or more, fill in the blank, and matching of two lists).

To receive feedback, students had to use web-based interface (feedback over SMS was not provided). As a result, students could be allowed to work in groups, sharing mobile phones, while still being able to view the feedback individually. Hence, students who did not own SMS-capable

Table 3. System evaluation. The participants were asked to answer yes or no to all questions except question 4, for which they were asked to rate the difficulty from 1 to 6 (with 1 for 'very difficult' and 6 for 'very easy'). All teams were pairs. The participants were asked to leave the questions that did not apply to their situation unanswered. In the table, the results for yes/no questions are calculated in an assumption that 'yes' is 0, while 'no' is 1

No	Question	Type	Mean	Std. dev.
1	The presence of a quiz increased my motivation when listening to the lecture	no—0, yes—1	0.67	0.50
2	I'd appreciate an opportunity to gain bonus points for answering quizzes at lectures.	no—0, yes—1	0.67	0.50
3	The necessity to use SMS messaging distracted me from the subject matter of the lecture. I would have scored much better result if I used just pen and paper	no—0, yes—1	0.44	0.53
4	Rate, how difficult it is to type SMS messages in specified format when answering quiz questions over SMS. 1—very difficult, 6—very easy	Likert scale	4.32	1.41
5	I worked on the quiz in a team	no—0, yes—1	0.67	0.50
6	Working on quiz questions in a team enhanced my learning experience (comparing to answering alone)	no—0, yes—1	0.50	0.50
7	Although when SMS quiz results are provided over standard Web interface it is possible to follow links to additional resources, I'd rather just receive a plain text summary over SMS, to my mobile phone	no—0, yes—1	0.56	0.53

phones could still have access to SMS interface as members of a group. Groups were identified as students using the same mobile phone number (so that there was no need for the teacher to manage groups). A higher security level could have been provided by allowing a group to set up and to share a password, but for the initial evaluation this feature was deemed to be unnecessary.

We observe that the system could be used to impose time and space constraints by indirectly encouraging students to attend lectures or tutorials (unless students are present, they cannot answer the questions, while late submissions by absentees are easy to distinguish by the time stamps they carry).

The system automatically rated the answers received via SMS, generated reports indicating each student's progress and offered links to Internet resources providing further information about the issues raised in the quiz questions.

We stress that there are indications that similar systems were implemented in the past [13], although we did not find any references that would discuss a similar system in detail. The focus of this work is not on technical novelty, but on prototyping and evaluating a system that would minimize the perceived problems associated with m-learning, and thus open way to its acceptance.

USER EVALUATION SETUP AND OUTCOMES

For evaluation purposes the system was used in a simulated classroom, with students acting as volunteers. The evaluation was executed as an introductory lecture on Python programming language (delivered by using PowerPoint slides), with a brief quiz offered at the end of the lecture. Students were sending answers via SMS directly from the classroom, in a predefined format. After the lecture, students accessed their results via a HTML-based interface (using ordinary PCs), and were able to broaden their understanding of the issues behind the questions by following the provided HTML links. Only then, they filled and returned the evaluation forms. The participating students were at graduate level. While only one of them did not carry a mobile phone (which was provided by evaluation organizers), many of the students opted to work in a group. The outcome of the evaluation (based on nine responses) is given in Table 3.

We observe that about half of the participants recognized increasing motivation and gaining credit as benefits of the system. While almost half of the participants would have preferred to use pen and paper, overwhelmingly, the special format used to answer questions via SMS was not perceived as a problem. While two-thirds of the participants opted to work in groups, only half of them reported that working in a group enhanced their experience, so it appears that in some cases groups were formed to save typing. Opinions were split as to whether feedback via SMS is preferable to accessing an HTML-based interface via a PC. It appears that ideally, both are desirable (as one of the participants indicated in a free-form comment).

An important issue that we encountered when processing the submission results, is that students tend not to follow strict guidelines on submission format. As SMS does not provide capabilities such as forms that would force the user to enter data in a given format, when using SMS to answer questions some sort of format guidelines need to be followed by the users. The evaluation trial involved four questions, covering three question types: multiple choice, multiple response, and fill-in-the-blank. Answers had to be encoded by answering each question on a new line, separating question number from the answer by a blank, etc. However, only two of the six submissions we received followed these guidelines completely, so that some manual editing had to be applied before the answers could be processed by the system. We, however, believe that this problem can be solved by using a more sophisticated parser to process the answers, as format deviations appeared to be predictable.

CONCLUSIONS

Most of the existing work on creating systems for m-learning concentrates either on applying advanced technology to support very narrowly defined educational objectives [5,6], or on wide-ranging, highly expensive systems that require high technical expertise to support them [7,8]. While systems following either approach may have merits as educational tools once they are accepted, neither of them is designed to facilitate acceptance, and in average educational institutions both are likely to face significant opposition.

We apply the Technology Acceptance Model to consider the requirements for a generic m-learning system that would maximize the likelihood of its acceptance and conclude that such a system should rely on the existing infrastructure and mobile device ownership, with SMS technology being the most appropriate technology under present conditions. We back this conclusion by evidence from a survey on m-learning acceptance targeted at educators, which demonstrates feasibility, and gauge acceptance by the learners by developing a system prototype and evaluating it in a simulated classroom environment. Overall, the results speak in favour of introducing low cost, low maintenance m-learning systems targeting average, budget conscious educational institutions, that would rely on the most common technology available, rather than on the most advanced technology available.

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