A MOBILE AND CONTEXT-AWARE LEARNING SCHEDULE FRAMEWORK FROM A PEDAGOGICAL PERSPECTIVE – AN INTERVIEW STUDY

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ABSTRACT

Mobile learning applications can be categorized into three generations – *rudimentary, adaptive* and *context-based/aware*. The research on our Mobile Context-aware and Adaptive Learning Schedule framework is motivated by some of the challenges within the context-aware mobile learning field. These include being able to create and enhance students' learning opportunities in different locations by considering different learning contexts and using these as the basis for selecting appropriate learning materials for students. We have adopted a pedagogical approach for evaluating this framework – an exploratory interview study with potential users consisting 37 university students. We targeted primarily at undergraduate computing students however students within other departments and also postgraduate students were included in our sample. This is so that a possible wider perspective of mobile learning from a student's point of view can be gained. The results findings have allowed us to refine the user requirements of our framework.

KEYWORDS

Context-based, interview study, pedagogical perspective

1. INTRODUCTION

A literature review into mobile learning and their applications identifies three generations of mobile learning principles motivating the practice of subsequent generations. The initial basis for the adoption of mobile learning has been the portability of mobile devices and the accessibility of learning materials from them, either offline or online. This represents the first *rudimentary* generation of mobile learning which was seen as "*e-learning through mobile computational devices"* (Quinn, 2000). Becking *et al*. (2004) noted that applications of this generation must consider the size and font, quality and scope, as well as how learning materials fit on mobile devices. Two further studies were identified by them in order to advance mobile learning research which relate to the subsequent two mobile learning generations. The first study corresponds to the *adaptive* mobile learning generation which focuses on the importance of adapting applications to learner profiles or models (attributes typically include learners' individual learning preferences) in order to provide learners with more tailored and personalized materials. The second study corresponds to the *context-based/aware* generation which stipulates the importance of selecting appropriate learning materials/activities to students (or filtering out inappropriate materials) based on their current learning situation which can be unpredictable within mobile learning environments. For example, the learner might be in a noisier location and not be able to concentrate well, and the location can be prone to interruptions. In this example, the noise level, concentration level and the frequency of interruption are termed '*learning contexts*' and these are used to describe different situations in mobile learning environments. A learning context space has been defined by Wang (2004) which describes many contextual factors within six different dimensions. The importance of this study has only recently come into light, despite the fact that applications researchers and developers have known that mobile devices were and could be used at any location at any time by learners.

Owing to the portability of using mobile devices for learning anywhere and at any time, learners have the flexibility to choose practically whichever location that suits them. For a full-time university student living on campus, this choice may not seem as crucial as for another part-time student who has family and work commitments and commutes onto campus every day, for example. The latter student has typically much more limited time than the former, and because of this constraint, it is much more important and necessary for the latter student to be able to use any time that they have and to be able to learn/study at any location. For example, it might be necessary for them to make use of the time when they are commuting each day on public transport. Becking *et al* (2004) also noted similar difficulties that distance learning students face because of this time constraint. The examples given were mothers having to wait with their children at the doctors and part-time students working as salesmen and having to spend a long time travelling to clients.

In order to work through some of the complexities within the context-awareness paradigm (discussed in section 2), we have previously developed a *Mobile and Context-aware and Adaptive Learning Schedule* (mCALS) framework (Yau and Joy, 2008) with the aim of implementing the framework on a mobile device. Its purpose is to create and enhance students' opportunities for learning/studying in different locations by taking into consideration a number of learning contexts. We have initially identified five learning contexts to be considered in this context-aware framework, namely student's learning styles, knowledge level, concentration level, frequency of interruption and their available time. We proposed the use of a *Learner Schedule* (i.e. an electronic calendar/organizer typically already built-in on a mobile device) primarily for capturing and storing the users' activities which can be retrieved and translated as learning contexts, and secondarily for helping students organize their work and facilitate time management. Our *Adaptation Mechanism* will then select/recommend appropriate learning materials for learners based on their learning contexts at the time of usage, and these learning materials will be selected from our *Learning Object Repository*. This paper is structured as follows – a literature review is provided in section 2. In section 3, we describe the results findings of our user-centered interview study and the refined user-requirements of our framework are presented. Finally, in section 4, we present our conclusion and future work.

2. LITERATURE REVIEW

Recent pedagogical-based mobile learning applications have been dealing with the following challenges -

1. Which learning contexts are important for the application for creating rich pedagogy-based mobile learning application? (Parsons *et al.*, 2007)
2. How should learning contexts be retrieved? Direct retrieval from the user (for example in Cui and Bull (2005)) requires time and effort and may interfere with what the user is doing. Alternatively, retrieval may be done implicitly by using sensors to detect the values of different learning contexts (for example in Schmidt (2002)). Note that for location-tracking, GPS is ineffective indoors and in public transport and RFID tags must be attached in specific areas beforehand in order to detect the user's location. A further issue is how to maintain users' privacy and integrity (Synnes *et al*., 2003).
3. Which learning materials/activities will be appropriate for learners to learn/study under which circumstances? Research has been conducted by Cui and Bull (2005) and Martin *et al*. (2006) in specifying this but currently there is no general consensus.
4. Learning contexts may continually change during a learning session – how can these be managed and should the user be continually receiving more appropriate learning materials/activities if their learning situation has changed? Martin *et al*. (2006) have developed a decision mechanism within their recommendation process which may/may not alert users about newly available activities.

3. EXPLORATORY INTERVIEW STUDY

Our research methodology, aims and questions are explained; thereafter, our interview data findings are described together with the refined user requirements which are derived from our interview study analysis.

3.1 Research Methodology

The initial decision to adopt an interview study as one of two approaches of our research methodology was to examine and evaluate our framework from a pedagogical perspective, prior to its technical implementation. Interviews "*can provide rich data and give considerable insight into perception and attitudes. Misconceptions of misunderstandings about what is being asked can be recognized and dealt with at the time. Interviewee has the opportunity to express opinions important to them, clarify ideas and feel that these are valued. The interview can be a learning process for both the interviewer and interviewee"* (Taylor *et al*., 2002). Our aim was to explore together with students (i.e. potential users of our application) three aspects. 1) What their learning requirements are when learning/studying in a mobile environment. 2) Whether our framework can potentially be used effectively to help them learn/study in different environments. 3) To use this user-centered understanding of students to form refined user requirements of our framework.

Our framework is targeted primarily at undergraduate computing students and we recruited the sample via lecture announcements and advertisement leaflets and asked for voluntary participation. However, we also wanted to obtain the perspectives of students from other university departments and also include postgraduate students in our study. The subject areas of our 37 interviewees include Computer Science and related (17), Business Studies and related (7), Mathematics (6), Engineering (2), Physics (1), Law (1), History (1), Industrial Relations (1) and European Cultural Policy and Management (1). All participants were university students including undergraduates students (in their 1st, 2nd, 3rd, and 4th year of study), as well as postgraduate students (master's and doctoral). The age range was 18-34. Our interview study commenced with a pilot run involving 5 students over two days and subsequently 32 students participated in our final interview study over three weeks. The same researcher conducted the interview throughout with participants on a one-to-one basis and the duration of each interview was approximately 25 minutes.

Limitations of our interview study include 1) our sample size of 37 participants consists primarily of students within our university which may not be representative of university students in general. Students from another university and/or from another country may have provided different perspectives during the interview study. 2) In order for participants to answer our interview questions, they are required to have an understanding of how best they learn/study and are able to reflect upon this and convey this information. The level of reflection and maturity in the understanding of students' own learning may vary between them. 3) Our framework is targeted primarily at university students and may not be representative towards students studying in other educational institutions including secondary schools and colleges etc.

3.2 Research Aims and Questions

Our interview study was designed and structured into the following four coherent topics; the research aims and questions within each of these topics are listed below –

(1) Learning/studying in different environments

Aim: To identify students' learning effectiveness within different learning environments so that further work can be performed to ascertain which learning materials would be appropriate for which learning environment.

1. *Where do students learn/study and which types of locations do they prefer to learn/study in?*
2. *Do students have preferences and requirements to learn/study effectively at different locations*?
3. *Which factors can distract their concentration for learning/studying?*

(2) Personal information management

Aim: To ascertain whether it is feasible for students to use an electronic-based schedule application for inputting, keeping up-to-date and also more importantly, following their scheduled events. This is central for our framework in order to capture our time and location contexts.

4. *Whether students actually use a learning schedule?*
5. *How closely do they follow it*?
6. *Would students be willing to input and have their diary events stored on a mobile device?*

(3) Learning characteristics

Aim: To establish the overall potential for students to use a mobile device for learning as well as determining whether students would object to the use of GPS for location-tracking, as our context-aware mobile learning framework may be required to use one to detect and verify the user's location.

7. *How do students view the use of mobile devices for learning/studying in different locations?*

8. *Would students object to the use of GPS for location-tracking?*

(4) Learning preferences

Aim: To confirm the pedagogical validity in our chosen learning contexts for our context-based framework and to establish whether the selection of appropriate learning materials for students in different environments under different circumstances will help them learn/study; and to attempt to determine which learning materials would be appropriate under which underlying values of learning contexts.

9. *How and if the adaptation of different learning contexts (namely a)* ***their learning style****, b)* ***knowledge level****, c)* ***concentration level****, d)* ***frequency of interruption*** *and e)* ***available time****) can help them with their learning/studying at different location*s?

3.3 Results Findings

Our interview results findings are described together with the refined user requirements of the framework. Not that the findings are sub-divided into four sections corresponding to the four areas of interview study and the finding numbers correspond to the research questions listed in 3.2. Content data analysis was selected as an appropriate qualitative analysis method for analysing our interview study.

3.3.1 Part A – Learning/Studying in Different Environments

Finding No. 1 – A variety of locations was specified by participants, revealing the typical locations where they conduct their learning/studying. These locations are classified into four different types of environments, and we have listed each of the specified location under the categories –

1) *Study-dedicated areas* - department office, computer laboratory, library, learning grid (flexible learning space within our university for studying in), quiet rooms around campus, corridors between lectures (this is not typically a study-dedicated area but is university/institution-based);
2) *Home areas* – bedroom, living room, dining room, kitchen;
3) *Café areas* – including student lounge; and
4) *Transport* – bus, train, plane.

Finding No. 2 – The reasons for preferring to learn/study in the stated locations were specified by participants and these typically include the following factors, which relate to the above four types of environments respectively. Note that there are some overlaps – some students may have more than one preferred location (or type of location) for learning/studying, and also there may be a varying degree of preference between students for preferring to study in the same location(s) - some specified they must study in a certain location due to their specific study requirements, whereas for some it is a matter of habit and/or convenience and they are more flexible to choosing other different locations in which they are also able to learn/study.

a) *Wanting to study in designated studying areas* - 23 participants commented they are motivated to learn/study in *study-dedicated areas* because they are generally quieter with fewer work-unrelated distractions, and they are encouraged by seeing others also studying. Participants may also choose these areas because they require library/computing resources. The *learning grid* (in our university) is preferred by many group project students because it has good group-work facilities such as presentation areas and whiteboards to work in/on. In the Computer laboratories, for example, participants found it more effective to collaborate and discuss programming problems with others.
b) *Preferring to study alone* – 24 participants prefer to study in their bedroom of their *home areas* because they a) preferred to study in a closed environment free of distractions from other people, b) found it more convenient and relaxing as they may listen to music in the background, take breaks and talk to others, and eat/drink, as and if they wish. On the contrary, a reason noted by some students of *not* preferring to study in this type of environment is that they wish to distinguish between their work and home life.
c) *Enjoying the presence of others* – 4 participants specified that they prefer to learn/study in *café areas* because a) they enjoy the presence of others around them when they are reading/brainstorming for ideas and gaining inspirations, b) they must have their freedom whilst studying, for example, to make phone-calls, eat/drink, talk to people (i.e. the *study-dedicated areas* would not be suited to these students), c) they find it psychologically motivating that they are progressing with their study whilst others are typically talking and relaxing.

d) *Making use of idle time* – 6 participants noted that they have studied or study regularly on *transport* such as on buses, trains and/or planes, with the typical reason of making use of idle/wasted time. Some of these participants noted that they find it comfortable and enjoyable to read whilst on transport and to make commuting time go quicker. Another reason for also studying on transport is due to tight coursework deadlines; however tight working space was reported as being a problem.

Finding No. 3 – Participants were asked to list as many factors in a location as they could think of that have a negative effect on their ability to concentrate, as listed below

a) *Noises - constant and sudden, people talking, keyboard typing*,
b) *Temperature – whether too hot or too cold*,
c) *Light – preferences for sunlight, bright light or dim light*,
d) *The layout of the room including the tidiness of desks*,
e) *Motivation – this has a huge effect in affecting students to do their work*,
f) *Food and drink – whether they are hungry and or thirsty*,
g) *Time of day – some people work better in some parts of the day than other parts*,
h) *Learning groups – some participants work more effectively when collaborating whereas others work more effectively alone*,
i) *How busy the environment is – the number of people around, coming and going*.

Conclusion – Throughout the interviews, it became apparent that each individual student has their own/different location preferences (although there might be similarities of these preferences between students). For example, a student might find it very effective to work in the quiet environment of a library whereas another may find it not possible to concentrate. Similarly, a distracting factor such as a noise (keyboard typing) may be very distracting for one student but not another. Therefore, a *Refined User-Requirement* of our framework would include establishing which learning environment is preferred by each learner, and how well they might learn/study in their current environment based on these known preferences/dislikes, and their learning effectiveness and productivity in these environments. Appropriate learning materials can be selected to learners based on this information; forming the basis of our future work.

3.3.2 Part B – Students' use of Diaries

Finding No. 4 – Three categories of diaries users were revealed from our interviews, as follows –

1) Paper-based diaries users (17) – participants noted that they enjoy the use of paper-based diaries because events can be referred to, added or deleted instantly, and that planning/assigning time for tasks to be completed is possible as the diaries allow students to visually see the free blocks of time in day/week/month format. They noted that it was more convenient than not having to switch it on (if their diary was electronic-based).
2) Electronic diaries users (10) – participants noted similar benefits as above, with the additional that they prefer their electronic diary integrated with their mobile phone/device. Typical electronic-based diaries software used by our participants include Kontact, Microsoft Outlook, and Google calendar.
3) 'Mental'/no diary at all (10) – these participants noted that it was not necessary for them to use a physical paper-based or electronic-based diary as they were able to remember their lectures/events/meetings/tasks/deadlines that they need to attend to or perform and that they were able to plan and schedule events/tasks in their mind clearly. Some also commented that they did not want a planned set of events to be carried out, but rather wanted to be spontaneous.

Finding No. 5 – Participants commented that they would follow their scheduled events that have been written in their paper-based diary or inputted into their electronic-based diary or for those who have a 'mental' or 'no diary at all' which are important to them such as lectures, seminars, and also meeting coursework deadlines and occasionally missing those less important events/tasks such as going to a yoga class.

Finding No. 6 – All of the participants except one commented that they had no objection to the idea of providing us with their diary events in order for our context-aware mobile learning tool to work effectively, as they will not be providing any information that is too personal to them or information that they would not want to divulge. The one participant who objected noted that the events would be too personal to divulge.

Conclusion – It has been revealed through our interview study that the majority of participants do use a learning schedule (either paper-based or electronic-based) with a small percentage of participants who do not use one; and that those who use a learning schedule commented that they do and are able to follow their

scheduled events. Consequently, we may assume that the learning schedule part of our framework will work effectively and successfully for at least a certain group of students. *Refined User-Requirements* derived from the interview include that the application must be user-friendly, easy to input and edit, require minimal effort to transfer lecture timetable information onto it, and allow weekly events to recur. Future work includes field-testing whether participants are actually following their scheduled events, rather than just relying on them commenting that they are following them.

3.3.3 Part C – Students' View on the Use of Mobile Devices for Learning/Studying

Finding No. 7 – Three different types of learner/users regarding the use of mobile devices were identified, as follows

1. *Enthusiastic to mobile learning* (11) – these users reported that they would (or already do) use mobile devices for a number of learning activities, for example, accessing lecture notes and audio files both offline and from the internet.
2. *Possible/potential to use mobile learning* (16) – these users noted that they would use mobile devices for learning/studying under specific circumstances such as when they are travelling/commuting/attending conferences.
3. *Not useful/no need to use mobile learning* (10) – these users noted that mobile devices would not be useful or that they have no need for them because of the following reasons, which are also supported by the findings of Wang and Higgins (2005) who noted that many people lack the psychological motivation needed for mobile learning.
    a. They would prefer to sit down at a desk to study/learn.
    b. They do not want to study/learn when outside dedicated studying hours.
    c. They do not like technology or would prefer to handwrite when learning/studying.
    d. Mobile devices are too small and they do not feel comfortable using them.

Finding No. 8 – 28 participants noted that they did not mind their location being tracked by the GPS function of mobile devices, however they noted that an option of being able to switch off the GPS function must be available. 9 participants noted that they would feel the location-tracking to be an intrusion and would mind people knowing their location mainly because they would not want others to know that for example when they are not in lectures/at work or not want to be contactable at all.

Conclusion – The responses of participants regarding whether they would use a mobile device for learning is quite divided. This is an issue which is quite hard to judge because many of the participants did not have a mobile device which they can perform mobile learning on and or did not want to or could not afford to purchase one. Many of the participants commented that if they had one made available to them, they would consider using it due to its portability and convenience whilst they are away from stationary locations but noted some disadvantages mainly due to its small screen size, it may be hard to input, and raises the question of what if it gets stolen. Regarding the GPS location-tracking, a *Refined User-Requirement* will be that an option must be made available to allow users to turn off the location-tracking if so wished.

3.3.4 Part D – Students' Learning Preferences/Contexts

Finding No. 9a) – In terms of whether learning styles are appropriate and necessary for adaptation within a context-based mobile learning framework, 31 participants commented that they would find it useful to have learning materials selected according to their *learning styles* because they feel that personalizing materials (for example, by presenting animated materials or math podcasts or illustrative examples and graphs to students who prefer them) to learners could mean that these materials are more effective for them. One student noted "*learning things are difficult and any kind of solution to make things easier would be good. You are hoping for the ultimate way of doing things*". On the contrary, 6 participants noted that they would not like to have learning materials selected to them based on their learning style because a) learning preferences may change depending on what it is that the student is doing, or from time to time, b) students would prefer to select or create their own learning materials themselves as sometimes the act of looking for materials can help or gain an overview of a topic.

Finding No. 9b) – In terms of whether students' knowledge levels would be appropriate for adaptation within a context-based mobile learning framework, 31 participants commented that they would find it useful to have learning materials selected to them according to their knowledge level because a) it would be frustrating to receive questions on a topic which is too easy or too advanced, b) students should not have to

learn something that they already know, c) to help you know your knowledge level so that you can concentrate on areas which need improvement. 6 participants noted the contrary because a) they are skeptical about whether the framework is able to find appropriate materials of their right knowledge level or of interest to the learner, and b) if allowed a wider spectrum of materials, they may have the chance to pick up extra knowledge.

Finding No. 9c) – In terms of whether students think whether they would find it useful to have learning materials selected according to their concentration level at the beginning of the study, a range of responses were received. For example, one student noted that it would be good if he/she was given podcasts to learn with using earphones in a noisy environment which would be easier than reading notes. However, another student noted that this wouldn't be helpful because although he/she is not in an ideal environment for studying, he/she may still need to attempt the solve difficult problems which had been assigned and the tool cannot just supply easy problems in this case. Similarly, some participants noted that adjusting the concentration has to be done by the learner him/herself and also in order to learn, he/she has to concentrate, and wouldn't know how their concentration level can be extracted and conveyed to the tool.

Finding No. 9d) – Many students were concerned about whether materials can really be selected according to the frequency of interruption at a location, how this frequency can be obtained and how this would affect the students' learning in that location. Positive feedback was received including that this could be a useful feature for keeping track of the place of learner's materials if they were to be interrupted, and also selecting smaller amounts of materials for learners when they are in locations with high frequency of interruption.

Finding No. 9e) – Relating to the selection of materials according to the available time function, most students agreed that this would be a useful time-management feature because, for example, some students may not want to start a new programming task when they have less than half an hour available and similarly a summary can be selected for students who have ten minutes prior to a lecture.

Conclusion – In terms of selecting learning materials appropriate for students' learning styles, knowledge level and available time, most students agreed that this would be suitable for them and could possibly enhance their learning effectiveness or help them learn/study at their location. However, many questions and complexities arise from concentration level and frequency of interruption learning contexts. Three related issues are of main concern 1) how will these be detected; 2) their accuracy if detected; 3) which learning materials will be appropriate for which concentration level and/or which frequency of interruption. The *Refined User-Requirement* for 1) and 2) may be a substitution of asking students to input these parameters themselves rather than attempting to detect them. Part of our future work will include 3) to ascertain appropriate materials for different values of these learning contexts. Other *Refined User-Requirements* include having learning objects in different formats stored on the mobile device and selected for the students based on the above listed learning contexts; and lastly the final control of the application should always remain with the learner and that the application should only provide a suggestion mechanism for the selection of learning materials which the learners have the option of accepting or declining.

3.3.5 Summary of Results Findings

Four typical types of learning environments were employed and preferred by participants including *study-dedicated areas, home areas, café areas* and *transport*. The reasons for these preferences include *preferring to study together with peers, alone, enjoying the presence of others and making use of idle time* respectively. Three categories of diaries users were revealed – *paper-based diary, electronic-based diary and mental diary/'no diary at all'*. Many of our participants found that their diary was an effective form of time-management tool and they were able to follow most of their important scheduled events. Three views on the use of mobile devices for learning were revealed from our participants – *enthusiastic to it, they may potentially use/need it, and no need/not useful at all.* The majority of participants did not object to GPS location-tracking whilst a minority of them prefers to have their privacy. Participants commented that the selection of appropriate learning materials based on the above listed learning contexts will be helpful for them, with concerns raised about the *concentration level* and *frequency of interruption* attributes such that *how can these be detected, their accuracy if detected, and which learning materials will be appropriate for which concentration level and/or frequency of interruption.*

4. CONCLUSION

Research in context-aware mobile learning and its applications is still in its infancy especially in terms of its pedagogical components. Our interview study has helped us become clearer about the potential feasibility of our framework for students to adopt as a mobile learning application for use in different environments. In particular, it has helped us to establish the appropriateness of our chosen learning contexts, the validity in using a learning schedule to store and retrieve contexts, and has confirmed that in order to help students learn/study in different environments it would be necessary to choose different learning materials appropriate for that environment. It has come to light that such a context-based mobile learning framework may have to be personalized to individuals based on their individual location preferences. More research is necessary for us to determine whether students can and do follow their scheduled events and to answer the remaining question of which learning materials will be appropriate for which type of mobile learning environment and their different associated circumstances. Our chosen research methodology for carrying out these field tests will be a "*diary: diary-interview*" (Zimmerman and Wieder, 1977) methodology which is currently in progress. The contribution of our work includes research into assisting students learn/study in different mobile environments and to provide appropriate context-based adaptation to students to increase their engagement with learning at various places.

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