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Original citation:
Yau, J. W. Y. and Joy, Mike. (2010) An adaptive context-aware mobile learning framework based on the usability perspective. International Journal of Mobile Learning and Organisation, Volume 4 (Number 4). pp. 378-390. ISSN 1746-725X

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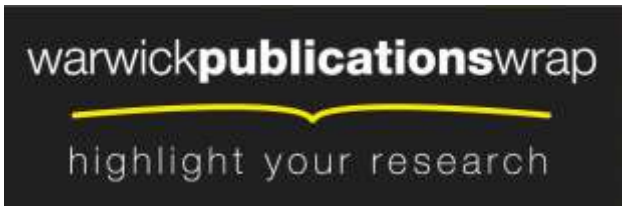

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Int. J. Mobile and Learning Organisation, Vol. X, No. X, 2010

An adaptive context-aware mobile learning framework based on a usability perspective

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Abstract: Three different types of context-aware mobile learning applications were revealed in our literature review – *location-dependent, location-independent* and *situated learning*. Our theoretical framework – mobile context-aware adaptive learning schedule (mCALS) was constructed. This uses a proactive approach – the learner's schedule (i.e. an electronic organizer) to retrieve the location and time available contexts. Other contexts are also considered – learning styles, knowledge level, concentration level and frequency of interruption. Thereafter, appropriate learning materials are recommended to students based on this information. We utilized a '*diary: diary-questionnaire*' research methodology for our usability feasibility in which 32 university students had participated in.

Keywords: context-based, usability study, '*diary: diary-questionnaire*' study, mobile learning

Reference to this paper should be made as follows: Yau, J. and Joy, M. (2010) 'An adaptive context-aware mobile learning framework based on a usability perspective', *Int. Journal of Mobile Learning and Organisation,* Vol. X, No. X, pp. XX-XX.

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1 Introduction

The importance of evaluating mobile learning (hereafter, abbreviated as m-learning) applications in terms of its pedagogical effectiveness cannot be over-estimated. This applies more so to the most recent generation of m-learning - context-aware m-learning applications (Yau and Joy, 2009). This generation places emphasis upon developing applications which are aware of the user's situation (defined by "*learning contexts*"). This is so that learning content/materials and/or tasks/activities can be matched, adapted or selected to students according to their current learning situation in their current mobile environment (Wang, 2004). Bradley (2005) noted that one of the most challenging aspects of generic context-aware computing research was how to build applications that can effectively deliver timely and relevant information to the user. In terms of context-aware m-learning applications, one must consider the pedagogical effectiveness as well as the technical and usability functionalities. Frohberg (2006) argued that "*embedding learning in context is the specific value of mobile learning"* and some of the common research aims within this paradigm included the following.

- Supporting learners to learn/study at anytime and anywhere by taking into account a number of learning contexts, such as location and the available time for study (Cui and Bull, 2005).
- Facilitating situated learning for students where situated learning can be defined as "*activities that promote learning within an authentic context and culture"* (Naismith *et al.*, 2004).

Our literature review showed that as research progressed, considerations from three different perspectives – *technical, usability and pedagogical* - were incorporated into the design and evaluation of m-learning applications and/or materials.

1. *Technical* considerations (focusing on mobile devices) included the physical layout of learning materials and how they should fit to the different sizes of screens of devices. Possible constraints include the small screen sizes and keyboards (Becking *et al*., 2004).
2. *Usability* considerations (focusing on learners) included the interaction between the user and device and how the user interfaces of applications on mobile devices should be designed. Possible constraints also include interruptions in the physical environment affecting students' ability to concentrate on the application (Taylor *et al.*, 2002).
3. *Pedagogical* considerations (focusing on learners) included the educational value of the content and how materials should be designed to enhance the learning experiences and to meet the learning requirements of students (Ibid).

Our research precisely tackles the design of a potential m-learning framework which uses a proactive approach for retrieving the users' learning contexts without the use of context-aware sensor technologies. The purpose of this proactive approach is to reduce the amount of interactions users are required to input into the devices to inform of their current situation. We have previously developed via an extensive literature review, a theoretical framework called the *Mobile Context-aware Adaptive Learning Schedule* (mCALS) (Yau and Joy, 2008). This framework uses the student's learning schedule (i.e. an electronic diary) integrated in the mobile device to retrieve their learning contexts. The pre-planning of scheduled events is desirable because the act of planning of study events can be a

motivational strategy for self-regulated students. Five important learning contexts were identified via the literature review and are incorporated into our framework. These are learning styles, knowledge level, concentration level, frequency of interruption and available time. Note that only the latter three contexts can potentially be retrieved from the learner's schedule. An suggestion mechanism will then be in placed to select appropriate materials to students based on their circumstances as represented by the contexts.

Our theoretical conceptual mCALS framework was constructed as a starting point to assist us in examining and analyzing the real potential of it, in terms of three perspectives – technical, usability and pedagogical. We conducted foremost the pedagogical study which consisted of 37 interviews with potential users of the framework, to ascertain the m-learning requirements of intended users and whether our framework could potentially be used by them; results of this study are in Yau and Joy (2009). Thereafter, we conducted a usability feasibility study using a '*diary: diary-questionnaire*' methodology to determine whether a diary approach can be used as a successful way of retrieving a) the user's learning contexts and, b) which learning materials would be appropriate for which circumstances. This paper is structured as follows – a literature review is provided in section 2; the 'diary: diary-questionnaire' methodology we employed to collect and analyze data is presented in section 3; we describe the results of the data analysis in section 4; and finally, in section 5, we present our conclusions.

2 Literature Review

Our literature review into recent context-aware m-learning applications demonstrates three different types of applications (Yau and Joy, 2009). The first of these are built specifically for a *location of use*. The second of these are developed for use *at any location* and these applications consider learning contexts at that location to supply the learner with appropriate learning materials. The third of these focus on facilitating the learner with *learning a particular theme in the situated environment.* We categorize these applications into a) *context-aware location-dependent learning*, b) *context-aware location-independent learning*, and c) *context-aware situated learning* respectively.

2.1 Context-aware location-dependent learning

These applications have in common that they use location-tracking technologies, such as Radio-frequency Identification (RFID) tags, Global Positioning System (GPS) and Wireless Local Area Network (WLAN), to identify the learner's location. Once this has been identified, appropriate learning materials are selected to them, based on the purposes of that application. These applications can only be used within the specified location range which is detected by the location-tracking technologies being used. For example -

- Learning Chinese at Taipei underground (Chen and Chou, 2007) was designed using RFID tags attached to the Taipei underground stations. A learner carries a Personal Digital Assistant (PDA) equipped with an RFID reader and uses this to access Chinese dialogs in these stations. This is to facilitate conversations to be held with the local staff and to help learners obtain the information required about the underground system.
- JAPELAS (Ogata and Yano, 2004a) was designed for learning Japanese expressions as these differ when used in different formality and when used speaking with people of a different/higher/lower rank. The system uses RFID tags which are attached to different meeting rooms (to simulate different formality). The learner uses a PDA and plays a role of a certain rank. Only appropriate expressions for that room and ranking will be displayed on the learner's device for them to practice.

- TANGO (Ogata and Yano, 2004a) has been designed to help Japanese students to identify English words with physical objects via the use of mobile devices which read, via RFID tags, the word corresponding to the object.
- Learning reminder (Ryu and Parsons, 2007) was designed to help students to find their way to different locations on campus (such as lecture halls). GPS is used for location-tracking and finding directions. Also contextual help is given to learners such as the notification of a book which has become available when they walk past the library.
- English vocabulary learning (Chen *et al*., 2007) uses WLAN positioning technologies to identify the learner's location in order to promote learner interests and performance. Using the learner's location, time for learning, and individual abilities information, appropriate learning content is selected, adapted and given to learners to learn/study with.

2.2 Context-aware location-independent learning

These applications have in common that they can be used anywhere and are not restricted to the specified location range. For example -

- TenseITS (Cui and Bull, 2005) teaches English language tenses to students and the materials selected are based on three learning contexts – concentration level, frequency of interruption and available time. These parameters are inputted by the students.
- JAMIOLAS (Ogata *et al*., 2006) simulates and helps foreign learners to recognize different physical situations/scenarios by presenting the visualizations of them, and then providing the correct corresponding Japanese impression/mimicry for them to learn.
- CLUE (Ogata and Yano, 2004b) makes use of the community context (i.e. the learner themselves and other learners surrounding them) for helping them to gain collaborative knowledge or to aid collaborative learning; making use of a 'knowledge awareness' map.

2.3 Context-aware situated learning

Naismith *et al.* (2004) noted that mobile technologies had the potential to help students visualize real-life concepts and could facilitate situated learning in real physical environments to enhance and reinforce students' learning. For example -

- Bird- (Chen *et al*., 2002) and butterfly-watching learning system applications (Chen *et al*., 2004) were developed to allow students to simultaneously watch real-life living things outdoors and access specific information and details about these from their mobile devices.
- A Savannah situated learning application (Facer *et al*., 2004) was developed in order to encourage students' understanding of animal behavior. This involves children simulating and acting out different animals. A particular task of the game involves having to avoid certain types of animals for survival.

3 Research Methodology

Our pedagogical feasibility (i.e. interview) study (Yau and Joy, 2009) was helpful for obtaining a clearer picture of how students deployed mobile technologies for their learning/studying and within their lifestyle. Further information was required to ascertain the following.

1) Whether students could plan their learning schedule ahead, conform to it and keep it up-to-date?
2) Could a diary approach be used as a successful way of retrieving users' learning contexts, namely the location and time available contexts?
3) Which learning contexts should be used for consideration as the basis for recommending pedagogically appropriate materials to students?
4) Which type(s) of learning materials would be appropriate for students under different circumstances?

This leads to our second usability feasibility study. We had selected the '*diary: diary-interview*' methodology (Zimmerman and Wieder, 1977) as one which would be appropriate for obtaining the data that we required and to fulfill our aims. However we have adapted this methodology to the '*diary: diary-questionnaire*' study. Reasons for this are given in 3.1 where we also explain the advantages of the diary study. In 3.2, an alternative usability study which we could potentially adopt is discussed. Finally, in 3.3, we provide information on our data sample.

3.1 The 'diary: diary-questionnaire' study and its advantages

In the '*diary: diary-interview*' methodology (Zimmerman and Wieder, 1977), the term '*diary'* refers to an annotated chronological record and is usually specifically designed and structured by a researcher to fulfill their set objectives. These '*diaries'* are requested to be filled in by volunteers and the period of time required to be filled in is usually set by the researcher. The '*diaries'* are then returned for the preparation of the '*diary-interview*' part. This interview is constructed based on the responses given by the individual, which is then conducted with that volunteer. Each '*diary-interview*' usually differs for each volunteer.

The '*diary: diary-interview*' study (Ibid) is argued to be efficient in obtaining data in situations which require direct and/or continuous observation, and in collecting large amounts of qualitative and quantitative data (Ross *et al*., 1994). Vavoula (2004) utilized this methodology for their investigation of learners' lifelong learning episodes and asked students to record these on a daily basis. This proved efficient because otherwise people may not always be able to recall accurately and precisely their experiences after a longer time had elapsed. This methodology has been made extensively used in the social sciences field including health, care of the elderly or handicapped, and time-allocation studies. Alternative methodologies include observational methods and the use of self-reports (Ross *et al*., 1994).

This methodology is appropriate and efficient for our usability study because of the nature of our framework requiring students being able to plan and keep to their diary. Therefore, our study was a pen and paper exercise which involved volunteers keeping a diary for two days and providing information about their study-related activities during these two days. Each of the designed diaries studies were identical for all participants and straight-forward to be carried out. They contained – 2 '*diary schedule*' sheets (one to be completed for each day of the study, including the start and finish time, location and nature of event), 20 sheets of '*diary entry*' (one to be completed for each study-related event, contained multiple choice questions for participants to indicate information regarding the reasons for their choice in that location for studying, how noisy it was, how motivated they were, how urgent the task was and how well they concentrated etc), 1 '*diary-questionnaire*' sheet (to provide information about diary planning, effects of various factors on their concentration etc) as well as an instruction sheet, and a consent form.

Our initial decision was to conduct the '*diary-interview*' with each participant and we had conducted the interview with 3 students in our pilot study, upon the return of their diaries studies to us. However, as we had already obtained a wide variety of students' perspectives and views towards their learning requirements in our pedagogical interview study, it was decided that the '*diary-interview*' part of the study was to be replaced by a '*diary-questionnaire*'. This '*diary-questionnaire*' consisted many straightforward questions to be completed by volunteers, and was able to provide us with the information required. We propose that this study is an effective methodology which allowed a) a more straight-forward approach for both the researcher and volunteers to conduct; b) the number of potential participants to be increased; c) volunteers to easily capture their daily activities for 2 days; d) this information to be easily inferred to us, and e) no additional necessary training time and financial resources.

3.2 Alternative usability feasibility studies

An alternative to our diary study was to use a functional implementation of a prototype of our framework on a mobile device for students to perform evaluation with. This would also require computer logs to be in placed to track the operations carried out by students. Advantages of this included that the evaluation would be conducted in the same authentic manner as the eventual product. Results which would be different to the pen and paper exercise may be obtained from this evaluation. The drawbacks and limitations of this approach included large amounts of time and financial resources would be required for a) the implementation and debugging process of the prototype; b) the number of mobile devices sufficient enough for volunteers to carry out the evaluation for 2 days; and c) the potential training time required if students were not familiar with using mobile devices.

Our aim in this usability study was to eliminate the possible technological influences which may affect volunteers if they were to use mobile technologies/devices for the evaluation of our framework, for example, this may affect how they behave. We also did not want to rely on computer logs as these could be unreliable. Software tends to also be less reliable and devices are known to have crashed during m-learning evaluations (Corlett *et al*., 2004). Current technologies are always improving, however it is the learner and their learning process that we wanted to focus on in this study. Our pedagogical interview results findings also suggested that although some participants did object to the use of mobile devices for learning in different locations, they did not object to generally studying in different locations (i.e. using paper-based materials). Therefore, we wanted to expand our framework to suggest that not only online but also offline materials be included. The evaluation of our framework using our proposed diary study was able to incorporate this.

3.3 Our data sample

We conducted a pilot study over a period of 2 days with 3 students - the purpose of this was to ensure a) all parts of the study were clear and non-ambiguous, and b) to provide an opportunity for reflection of the structure of the study and the questions in light of responses from volunteers. Thereafter, 13 students participated in our main study. 11 of these 13 students were computer science students, the remaining were a law and an engineering student; the data from these 13 students and the three pilot students are named *batch 1*. These 13 students were from the following institutions:

- 10 (University of Warwick),
- 2 (German Language school), and
- 1 (University of Nottingham).

We were also able to obtain 16 volunteers via a colleague from the PA College in Cyprus. The students from the PA College were enrolled on the following courses:

- Business Computing (4),
- Accounting (3),
- Marketing (2) and
- Business Administration (7).

The data from the students from the PA College are named *batch 2*. The age range of participants was 18-30 and they were in various years of study. The total participants were 32.

A diary was kept by 32 students with each filling in a diary of two days. This formed a total of 64 days of diary to be analyzed. Volunteers were asked to complete a diary entry form for each of their study-related events that they had planned out in the diary schedule.

A total of 157 diary entry forms were completed, 109 were from participants of *batch 1* and 48 were from participants of *batch 2*. Each participant (except one) completed the diary-questionnaire, forming a total of 31 completed diary-questionnaires for analysis. A sufficient amount for our data analysis was collected. In the diary study carried out by Vavoula [**Error! Bookmark not defined.**], they had obtained 118 learning experiences from 12 students volunteers.

4 Data Analysis

Preliminary data analysis of our '*diary: diary-questionnaire*' from our diary schedule sheets show that all of the *batch 1* participants did successfully plan out both their study-related and study-unrelated events for the two days; however the *batch 2* participants only planned out their study-related events. A possible explanation of this was that the study coincided with their exam period; hence they were very busy attending revision lectures, and doing self revision, and omitted other study-unrelated events which they may have felt to be irrelevant and/or less important to them at that point in time. A total of 275 events were recorded from these 32 students - 181 of these were study-related events and 94 were study-unrelated events. The preliminary data analysis for the following four research questions (as mentioned in section 3) are presented in 4.1, 4.2, 4.3 and 4.4 respectively.

4.1 Whether students can plan their schedule ahead, conform to it and keep it up-to-date?

All 32 of the participants were able to plan their schedule ahead for the 2 days required. The *batch 1* and *2* participants noted the following planned activities in their *study-related* events:

- programming tasks/laboratory exercises/computer projects,
- meetings with peers and supervisors,
- assignments,
- coursework,
- writing reports and thesis,
- lectures and seminars,
- language studies and exam revision, and
- research and brainstorming.

The *study-unrelated* events noted included the following:

- reading leisure books,
- watching news and TV,
- writing emails,
- setting up software,
- chatting online,

– travelling to university, and
– sports, meeting friends, taking rests/breaks, and eating.

Out of the 275 events noted by participants, 251 events were noted by participants that they had adhered to these. 23 instances (19 were *study-related* and 4 were *study-unrelated*) were indicated *not* to gone as anticipated by 8 participants in *batch 1*. Only one event was indicated by a *batch 2* participant as not to have gone as anticipated and this was due to boredom. All of the *batch 1* and *2* participants noted that they did not have any problems updating the schedule. Explanations for the events not having gone as anticipated were provided by the 8 participants from *batch 1*.

- Participants' reasons given for the study-related events include - a) their planned tasks required a longer time for completion or were more complicated than expected, b) they were interrupted often, sick, tired or had low levels of productivity and decided to either not commence or discontinue with the activity, c) their scheduled events were cancelled, delayed, postponed, rescheduled or exceeded the scheduled time, and d) there were occurrences of delays in transport.
- Participants' reasons given for study-unrelated events - a) they changed their minds regarding their planned activities that they had wished to carry out, for example from doing an assignment to answering emails, or deciding to relax after a long day of study rather than doing more, b) the location of a meeting place with friends was changed, and c) due to lack of time.

4.2 Can a diary approach be used to retrieve the location and time available contexts?

91% of the events (251 of 275) scheduled by participants at the beginning of the day went as anticipated. This gave a general indication that the location and available time of a student at a particular point in time can be retrieved accurately from the learner's schedule. In addition to this, all of the *batch 1* participants indicated that they were always in the location that they had planned, except for two participants who noted that they occasionally would complete their previous activities together with their current one in the same location. Out of the *batch 2* participants, 8, 2 and 5 indicated that they were *always, sometimes* and *not* in the location that they had planned respectively.

Participants noted a) the start and finish time of their scheduled events at the beginning of the two days of the diary study, and b) for each of the study-related events, the actual start and finish times of these events on the diary entry forms. Our data analysis showed that the planned and actual start and finish times of 52 of the 109 study-related events (47%) were matched; whereas the remaining 57 events (i.e. 53%) showed 20 of these events a) had discrepancies within 5 minutes – owing usually to the lectures at our university starting at five past the hour and finishing at five to the hour and volunteers usually rounded this to the hour in their planned schedule; b) discrepancies within up to an hour – this is usually when students planned self-studies, and they allowed themselves the flexibility to start and finish earlier/later than planned. The planned and actual start and finish times of only 4 out of 48 study-related events recorded by the *batch 2* participants were mismatched. One of these four events was a scheduled class and the remaining 3 were self-study. The actual start and finish times of 9 students were precisely conformed to their planned start and finish times, as indicated. 5 students did not note down the actual start and finish times of their events; however common amongst the *batch 2* participants were 2 daily laboratory revision exercises classes, in preparation for their exam. We presume that due to the importance of these events, the students had attended them from start to finish. The actual and planned start and finish times of 2 students did not match.

4.3 Which learning contexts should be used for recommendation?

Participants were asked to indicate whether the following factors affected their concentration in terms of studying – *noise, busyness of the environment, temperature,* and *motivation*. Our literature review and interview study analysis showed that these factors may contribute either positively or negatively in terms of a student's concentration level required for learning/studying. (Note that 31 out of 32 participants completed the questionnaire).

- 25 participants noted that the *noise* had an effect whereas 6 noted the contrary.
- 21 participants noted that *busyness of an environment* had an effect whereas 10 noted the contrary.
- 18 participants noted that *temperature* had an effect whereas 13 noted the contrary.
- 27 participants noted that *motivation* had an effect whereas 4 noted the contrary.

4.4 Which type(s) of learning materials are appropriate for which circumstances?

We had asked participants to name activities that they would carry out when they had a) *less than 15 minutes,* b) *15-30 minutes,* c) *30 minutes to an hour, and* d) *over an hour*, available for studies. Participants indicated when they had a shorter time for learning/studying, they would choose shorter and easier activities such as planning, brainstorming, reading, or none at all (as the time available is too short). They indicated that when they had more time available, they would carry out more difficult tasks requiring more concentration such as writing assignments and/or coursework, and programming etc. Further data analysis is required.

5 Conclusions and Future Work

The results of our diary study indicated that students were able to plan their schedule and conform to it at a feasible degree of accuracy. Noise and the students' motivation for their studies played an important role in affecting their levels of concentration. Three feasibility studies for the evaluation of our *mCALS* suggestion framework were employed forming collectively our evaluation pillars. Preliminary data analysis had been conducted on both of our pedagogical and usability studies. Further thorough data analysis is required to extract fully a) the final requirements of our framework appropriate for potential users, b) the essential learning contexts for the recommendation of learning materials in a mobile learning environment, and c) the types of learning materials which are appropriate for learners in different contexts. Our third technical feasibility study forms a software design of the framework, to examine whether an implementation of it can realistically and successfully be deployed using current technologies. The final product of which will be used by university students for learning the Java programming language in different contexts and environments. Our research is focused on providing appropriate learning materials to students based on their current learning contexts. The question of whether learners are motivated to learn from such a context-aware suggestion mechanism system is currently beyond the scope of our research. Martin and Carro (2009) have developed and evaluated a similar context-aware suggestion mechanism system. Their results indicate that such a system could "motivate students to learn in different contexts and active ways, for example, by proposing and allowing them to interact with online educational resources through handheld devices, suggesting them different activities according to their particular context so that they can benefit from idle time to study" (Ibid).

Acknowledgement

This journal paper has been extended from the conference paper titled "*A mobile and context-aware adaptive learning schedule framework from a usability perspective - a 'diary: diary-questionnaire' study*", which appears in the proceedings of the International Conference on Computers in Education, 2009, pp. 512-519.

References

Becking, D., Betermieux, S., Bomsdorf, B., Birgit, F., Heuel, E., Langer, P. and Schlageter, G. (2004) 'Didactic Profiling: Supporting the Mobile Learner', In G. Richards (Ed), World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education, Chesapeake, VA: AACE, pp. 1760-1767.

Bradley, M. (2005) *A user-centred design framework for context-aware computing*: *a PhD thesis*. University of Strathclyde, UK.

Chen, Y. S., Kao, T. C., Sheu, J. P. and Chiang, C. Y. (2002) 'A mobile scaffolding-aid-based bird-watching learning system', Paper presented at the *International Workshop on Mobile Technologies in Education (WMTE 2002)*, pp. 15-23. In proceedings.

Chen, Y. S., Kao, T. C., Yu, G. J. and Sheu, J. P. (2004) 'A mobile butterfly-watching learning system for supporting independent learning', Paper presented at the *International Workshop on Mobile Technologies in Education (WMTE 2004)*, pp. 11-18. In proceedings.

Chen, C. H. and Chou, H-W. (2007) 'Location-aware technology in Chinese language learning', Paper presented at the *IADIS International Conference on Mobile Learning*, pp. 189-193, Lisbon, Portugal. In proceedings.

Chen. C. M., Li, Y. L. and Chen, M. C. (2007) 'Personalized Context-aware ubiquitous Learning System for supporting effectively English vocabulary learning', Paper presented at the *International Conference on Advanced Learning Technologies (ICALT 2007)*, pp. 628-630. In proceedings.

Corlett, D., Sharples, M., Chan, T. and Bull, S. (2004) 'A Mobile Learning Organiser for University Students', Paper presented at the *International Workshop on Wireless and Mobile Technologies (WMTE 2004)*, pp. 35-42. In proceedings.

Cui, Y. and Bull, S. (2005) 'Context and learner modeling for the mobile foreign language learner', *Science Direct, System 33 (2005)*, pp. 353-367.

Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R. and Kirk, D. (2004) 'Savannah: mobile learning and gaming?', *Journal of Computer Assisted Learning 20,* pp. 399-409.

Frohberg, D. (2006) 'Mobile Learning is coming of age – what we have and what we still miss', Paper presented at *DELFI: 4, e-Learning Fachtagung Informatik er Gesellschaft fur Informatik*, pp. 327-338. In proceedings.

Martin, E. and Carro, R. (2009) Supporting the development of mobile adaptive learning environments: a case study. *IEEE Transactions on Learning Technologies*, vol. 2, no. 1, pp. 23-36.

Naismith, L., Lonsdale, P., Vavoula, G. and Sharples, M. (2004) Literature review in mobile technologies and learning: *NESTA Futurelab Series, Report 11*.

Ogata, H. and Yano, Y. (2004a) 'Context-aware Support for Computer-Supported Ubiquitous Learning', Paper presented at the *International Workshop on Mobile Technologies in Education (WMTE 2004)*, pp. 27-35. In proceedings.

Ogata, H. and Yano, Y. (2004b) 'Knowledge Map for computer-supported ubiquitous language learning', Paper presented at the *International Workshop on Mobile Technologies in Education (WMTE 2004)*, pp. 19-26. In proceedings.

Ogata, H., Yin, C., and Yano, Y. (2006) 'JAMIOLAS: Supporting Japanese mimicry and onomatopoeia learning with sensors', Paper presented at the *International Conference on Hybrid and Information Technology*, pp. 111-115. In proceedings.

Ross, M., Rideout, E. and Carson, M. (1994) 'The Use of the Diary as a Data Collection Technique', *Western Journal of Nursing Research*, vol. 16, no. 4, pp. 414-425.

Ryu, H. and Parsons, D. (2007) 'A learner-centred design of a location-aware learning reminder', *International Journal Mobile Learning and Organisation,* vol. 2, no. 2, pp. 187-200.

Taylor, J., Mistry, V., Sharples, M. and Ahonen, M. (2002) D2.2 Evaluation Methodology: *MOBIlearn/OU/D2.2/1.0.*

Vavoula, G. (2004) *A knowledge and learning organization system in support of lifelong learning: a PhD thesis*. University of Birmingham, UK.

Wang, Y. (2004) 'Context-awareness and Adaptation in Mobile Learning', Paper presented at the *International Workshop on Mobile Technologies in Education (WMTE 2004),* pp. 154-158. In proceedings.

Yau, J. and Joy, M. (2008) 'A Self-Regulated Learning Approach: A Mobile Context-aware and Adaptive Learning Schedule (mCALS) Tool', *International Journal of Interactive Mobile Technologies*, vol. 2, no. 3, pp. 52-57.

Yau, J. and Joy, M. (2009) 'A mobile context-aware framework for managing learning schedules - data analysis from an interview study', *International Journal of Mobile and Blended Learning,* vol. 1, no. 4, pp. 29-55.

Zimmerman, D. and Wieder, D. (1977) 'The Diary: Diary-Interview Method', *Urban Life*, vol. 5, no. 4, pp. 479-498.