

Open Research Online

The Open University's repository of research publications and other research outputs

The evaluation of next generation learning technologies: the case of mobile learning

Conference or Workshop Item

How to cite:

Traxler, John and Kukulska-Hulme, Agnes (2006). The evaluation of next generation learning technologies: the case of mobile learning. In: ALT-C 2006: The Next Generation. Research Proceedings of the 13th Association for Learning Technology, 5-7 Sep 2006, Heriot-Watt University, Scotland.

For guidance on citations see [FAQs](#).

© [not recorded]



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Version of Record

Link(s) to article on publisher's website:

http://www.alt.ac.uk/altc2006/altc2006_documents/research_proceedings_altc2006.pdf

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

ALT-C 2006 Research Paper

Traxler, J & Kukulska-Hulme, A. (2006). The Evaluation of Next Generation Learning Technologies: the Case of Mobile Learning. In Whitelock, D. & Wheeler, S. (Eds). *The next generation*. Research Proceedings of the 13th Association for Learning Technology Conference (ALT-C 2006). Held 5–7 September 2006, Heriot-Watt University, Scotland, UK.

The Evaluation of Next Generation Learning Technologies: the Case of Mobile Learning

Abstract

Mobile learning is at a leading edge of learning technologies and is at present characterised by pilots and trials that allow mobile technologies to be tested in a variety of learning contexts. The sustained deployment of mobile learning will depend on these pilots and trials, especially their evaluation methodology and reporting. The paper examines a sample of current evaluation practice, based on evidence drawn from conference proceedings, published case studies, and other accounts from the literature and draws on the authors' work in collecting case studies of mobile learning from a range of recent projects. The issues discussed include the apparent objectives of the documented pilots or trials, the nature of the evaluations, instruments and techniques used, and the presentation of findings. The paper reflects on the quality of evaluation in mobile learning pilots and trials, in the broader context of evolving practices in the evaluation of educational technologies.

Introduction

The last four years have seen a dramatic increase in the number and variety of pilots and trials in mobile learning – learning that involves the use of mobile or wireless devices. This increase has been reflected in and supported by submissions to the ALT, MLEARN, WMTE and IADIS conference series, and by the emergence of smaller regional conferences. The growing pedagogic and technological sophistication of mobile learning pilots and trials is evident, but increased and sustained deployment of mobile learning will depend of the quality of analysis and evaluation of these early projects.

Evaluation and analysis are key to the embedding of mobile learning and perhaps all forms of innovation in learning technology. First, they inform the outside world about the effectiveness of pilots and trials, specifically in relation to the objectives they set out to achieve, and second, they provide some insights to funders and champions on the utility and cost-effectiveness of the projects they support. In many cases, evaluation determines whether pilots become ongoing provision. Our key aim in this paper is to encourage the learning technologies community to debate the suitability of current evaluation approaches in relation to emerging technologies such as those employed in mobile learning.

Historically, the development of evaluation strategies for educational trials and pilots has focused on face-to-face contact with students working in cohorts on courses in classrooms, lecture theatres and laboratories. Evaluation has depended on a small, stable repertoire of techniques, embracing observation, interview, focus group and questionnaire. More recently, learning technology evaluation has supplemented and cross-referenced these with analysis of

system logs and technical data. In other areas of social research, for example policy interventions, and to a lesser extent, in areas of schools-based educational research, evaluation is a complex and mature discipline (see for example, Patton 2001).

Now, the changing political, economic and social climate is forcing and encouraging educational institutions and their funders

- to address new constituencies of learners, such as ‘access’ students without adequate study skills and full-time students forced to hold down substantial part-time jobs
- to deliver informal and life-long learning, alongside conventional structured courses and programmes; and other components of a larger political agenda such as personalised learning, work-based learning and skills-for-life
- to engage with industry and commerce by delivering more training and more vocational education; to compete globally and deliver internationally
- to work within more and more precise quality and regulatory regimes
- to teach increasing numbers of students in spite of static financial resources and inadequate and ageing estate.

This suggests that ‘next generation’ trials and pilots working with new learning technologies in these environments, in our case mobile technologies, must question the efficacy of traditional evaluation techniques and must adapt and explore more imaginative and varied evaluation approaches. This is in itself problematic because it raises concerns about the validity of untried evaluation techniques and about the transferability and relevance of techniques adapted or adopted from other disciplines.

To address these issues, we review current evaluation practice, based on evidence drawn from conference proceedings, published case studies, and other accounts from the literature. We also draw on our own work in collecting case studies of mobile learning from recent projects. We consider the objectives of the documented pilots or trials, the nature of the evaluations, instruments and techniques used, and the presentation of findings. Finally, we reflect on the quality of evaluation in mobile learning pilots and trials, in the broader context of evolving practices in the evaluation of learning technologies.

The Purposes of Evaluation

There are no *a priori* attributes of a ‘good’ evaluation - to say that there were, would be to take an implicitly realist or essentialist position that not every stakeholder would agree with, and would confront a widely held view that in fact evaluation is a contingent activity. In an earlier work, we tried to outline some candidate attributes of a ‘good’ evaluation (Traxler 2002) but we also identified the reasons why evaluation of mobile learning is unusually challenging. Briefly some of these attributes were that a ‘good’ evaluation should be:

- Rigorous, meaning that conclusions must be trustworthy and transferable
- Efficient, in terms of cost, effort, time
- Ethical, specifically in relation to evolving and untried forms of provision
- Proportionate, that is, not more ponderous, onerous or time-consuming than the learning experience or the delivery and implementation of the pilots themselves

- Appropriate to the specific learning technologies, to the learners and to the ethos of the project concerned – ideally *built-in*, not *bolted-on*
- Consistent with the teaching and learning philosophy and conceptions of teaching and learning of the participants
- Authentic, in accessing what learners (and perhaps teachers and other stakeholders) *really* mean, *really* feel, and sensitive to the learners' personalities within those media
- Aligned to the chosen medium and technology of learning
- Consistent across:
 - different groups or cohorts of learners in order to provide generality
 - time, that is, the evaluation is reliably repeatable
 - whatever varied devices and technologies are used

All of these attributes are open to question and examination and many will have nuances that are specific to mobile learning. For example, the issue of consistency is challenging since mobile technologies are changing at an exceptionally fast pace and consequently it is difficult to reach an understanding of underlying issues and concepts. Some issues around ethics have been explored elsewhere recently (Traxler and Bridges 2004); mobile learning continues however to evolve, and any account of the ethics of evaluation should now, for example, address the issue of using virtual ethnography to evaluate mobile blogging.

There are a variety of authors offering complementary or perhaps competing criteria or attributes for all the various aspects of evaluating mobile learning. One way of addressing this complexity and of exploiting growing experience and expertise would be to use (online) Delphi techniques to develop more consensual criteria (see for example, Des Marchais 1999). We could also use 'contrived' elicitation techniques (Rugg and McGeorge 1992) to uncover the value systems that underlie experts' evaluation criteria and thus explore the articulation between experts' values and their ideas about evaluation.

We can in any case make some progress on the basis that documented mobile learning pilots and trials each have their own aims and objectives, and that these should have driven evaluation in defining the outcomes to be assessed by the evaluation and hence driving the selection and development of the techniques, instruments and protocols used in evaluation.

We should perhaps however recognise that behind the explicit aims and objectives of a trial or pilot lie the culture and affiliations of those implementing, managing and funding it. They may be working as teachers, researchers or consultants and the expectations on each will necessarily be slightly different. Researchers are funded to look for possible answers, consultants are funded to deliver solutions and teachers are duty-bound to do their best. Different evaluation mindsets will also apply to projects that set out to test only technical stability or to trial specific interface designs without explicitly addressing their impact on educational activity.

Furthermore, mobile learning takes place in a wider social context and evaluation must also recognise this. In fact, we could argue that quintessential mobile learning *only* takes place in a wider social context and many trials and pilots of mobile learning have been funded to explore these wider social and economic benefits. There is increasing recognition of such

benefits but also of the difficulty of evaluating them appropriately (Dewson *et al.* 2002). In this context, mobile learning pilots and trials can receive funding to build capacity and increase cohesion within communities and to improve social inclusion; the pan-European *m-learning* project (www.m-learning.org) is an obvious example, as are its smaller spin-offs with travellers and the homeless. In these cases, lifelong learning or community education might only be the means to these ends and mobile learning technologies may only be the vehicles to carry them. In such cases, the cognitive gains are likely to be irrelevant – indeed, any kind of learning gains might be irrelevant, nevertheless evaluation of some kind must still take place.

Similar examples can be found in developing countries where mobile learning is being used to address problems of capacity and infrastructure (Leach *et al.* 2005; Traxler 2005). A recent review of evaluation in these settings begins to address the evaluation of learning technologies in developing countries but only mentions mobile learning very briefly (Wagner *et al.* 2006).

Current Evaluation Practice

This section reviews current mobile evaluation practice, as described in recent reported case studies, pilots and trials (Kukulska-Hulme and Traxler 2005; Attewell and Savill-Smith 2004). The review focuses on the aims and objectives of the projects, and their evaluation methods and techniques. Aims and objectives were examined by first identifying and extracting all those that were mentioned explicitly and then by clustering those that expressed similar intent. Methods and techniques were examined by identifying and extracting all those that were mentioned explicitly, and then reviewing how various techniques had been used. The sample is relatively small and arbitrary, and the accounts themselves may be an incomplete or inaccurate reflection of the actuality. The case studies (Kukulska-Hulme and Traxler 2005) were written to a template specifically designed to produce consistent accounts that exposed the relationships between objectives, methods and evaluation; the conference contributions (Mlearn 2003 papers, in Attewell and Savill-Smith 2004) were shorter and less consistent and may have discussed technologies that were not mature.

In looking at our sample, we find that most of the projects can be characterised as ‘first-generation’ – the technologies used were not always stable, mature or well understood and technical difficulties sometimes hampered the educational delivery and the subsequent evaluation. The sample also seemed to be generally ‘first generation’ in the sense that most of the trials and pilots were not building on an established base of expertise or equipment. It could be argued that this had consequences for the types of objective that were appropriate, shifting the balance away from answering specific research questions and towards identifying, refining or prioritising such questions, or perhaps just demonstrating technological and pedagogic possibilities. Whichever it was, this issue has considerable implications for evaluation, both in the general sense of understanding the technological and pedagogic contexts but also in the specific sense of evaluating the alignment of objectives, methodology and outcomes.

The evaluations in our sample were usually formative (in that changes took place as a consequence). With a few exceptions, the evaluations were not usually conducted by external staff or by evaluation specialists. Very few of the accounts made direct reference to the

literature of evaluation and consequently there was not normally a justification or explanation for the evaluation methods or instruments chosen. There were also few references to ethics as a potential factor in evaluation. The exceptions related to privacy and context-awareness (Lonsdale *et al.*, 2004). The following sections briefly highlight how the multiplicity of aims and objectives poses challenges for evaluation and reflect on the limited range of evaluation techniques that are being used.

Aims and Objectives of Pilots and Trials

An analysis of 12 international case studies in Kukulska-Hulme & Traxler (2005) reveals that reasons given for using mobile technologies in teaching and learning relate principally to improving access, exploring changes in teaching and learning, and alignment with institutional or business aims, as illustrated by these examples:

- Access:
 - Improving access to assessment, learning materials and learning resources
 - Increasing flexibility of learning for students
 - Compliance with special educational needs and disability legislation
- Changes in teaching and learning:
 - Exploring the potential for collaborative learning, for increasing students' appreciation of their own learning process, and for consolidation of learning
 - Guiding students to see a subject differently than they would have done without the use of mobile devices
 - Identifying learners' needs for just-in-time knowledge
 - Reducing cultural and communication barriers between staff and students by using channels that students like
- Alignment with institutional or business aims:
 - Making wireless, mobile, interactive learning available to all students without incurring the expense of costly hardware
 - Delivering communications, information and training to large numbers of people regardless of their location
 - Blending mobile technologies into e-learning infrastructures to improve interactivity and connectivity for the learner

A review of the 27 projects documented in the proceedings of MLEARN 2003 (Attewell and Savill-Smith 2004) shows a similar spread of objectives:

- Access:
 - trying to ensure that every student can access content independently of the channel he or she chooses to use
 - the use of a PDA as an assistive technology
 - ensuring that classroom-based pupils benefit from the experience of a field trip being undertaken by their peers
- Changes in teaching and learning:
 - individualisation:
 - to explore the potential for individualised mobile learning - revision material tailored to the needs of the individual

- to provide learners with a flexible context-awareness system that can react to their needs
- collaborative and active learning:
 - immediate feedback through interactive tests: the user knows in real time if their choice is correct
 - interactive screens encouraging art gallery visitors to respond to the art on view
 - a set of innovative games, materials and activities which will motivate reluctant young learners
 - enhancing interactivity and cooperation while preserving the traditional advantages of face-to-face encounters
- informal learning with multiple media:
 - to investigate how self-produced videos, made with a digital video camera and later viewed on handheld mobile computers, can support informal learning
 - to provide video and still images giving additional context for art gallery works on display, opportunities to listen to an expert talk about details of a work, with the details simultaneously highlighted on the screen
 - enhancing the audio presentation of a multimedia museum guide by using the PDA screen to travel throughout a fresco and identify the various details in it
- cognitive and behavioural change:
 - to explore how context-dependent learners' knowledge concepts are
 - to evaluate fragmentation in mobile learning based on students' deep and surface approaches to learning
 - to capture learners' thoughts, views and behaviours in a mobile learning setting
- Alignment with institutional or business aims:
 - to remain at the cutting edge of educational technology by helping to shape a new generation of multimedia tours in art galleries
 - development of a service model and new component concepts for lifelong mobile learning

The authors of the case studies and papers do not always categorise their own objectives in the way that we have, and they do not prioritise competing objectives explicitly. Objectives can usually be identified quite clearly in the abstracts, whilst in the actual papers they may be introduced and discussed at various points in the paper. They are not presented as being linked to evaluation methods in any explicit way. Objectives typically focus on new opportunities, exploration of potential, introduction of new media, or initial exploration of attitudes and patterns of use. The authors may be seeking to encourage or enhance certain ways of learning. Such outcomes may be hard to measure, especially during a relatively short period of technology use.

For trials and pilots to be consistent and coherent, the aims and objectives must be aligned to the methods, outcomes and evaluation. Looking at this review of aims and objectives, we can see that in general they represent a considerable challenge in terms of formulating appropriate evaluation instruments and techniques. This is in part due to the inherently ‘noisy’ nature of much of mobile learning – it is often characterised as informal, spontaneous, lightweight and situated for example – and in part due to the generalised nature of the aims and objectives. It is sometimes difficult to imagine outcomes from trials that would establish that these aims and objectives have been met.

Given the present state of knowledge in the field of mobile learning, considerable skill is required in formulating objectives. In research projects, the aims may be exploratory and should perhaps seek to retain openness to unexpected findings. Clearly, this is problematic for some styles of formal summative evaluation that audit achievements against objectives without recognising that some objectives may only emerge as projects evolve. It may also become apparent that some initial objectives are disproportionately expensive or impractical to realise. A more fluid, formative and engaged style of evaluation may on the other hand run the risk of losing its perspectives or objectivity (by ‘going native’).

These are some of the issues in exploring how mobile learning evaluation should engage with project objectives. They are issues with a very direct bearing on the methods and techniques of evaluation.

Methods and Techniques

The majority of pilots and trials in our samples had no apparent epistemological (or educational) foundations. They may nevertheless have had some tacit foundations that were *not-worth-mentioning*, *taken-for-granted* or *common-sense*. Where their foundations were explicit, they were usually social constructivist and underpinned the pedagogy. There was not usually any statement about the corresponding foundations of the evaluation and this was problematic. Basing a pilot or trial on explicit epistemological foundations would implicitly raise the issue of whether or not the evaluation should be aligned with them, and would give an added depth to the discussion of its findings. It also opens up the ethical dimension of the project or trial and its evaluation.

A crucial element of the evaluation of mobile learning trials and pilots is the elicitation of learners’ attitudes and achievements. We found that the elicitation techniques used were usually questionnaires, interviews and focus groups, supplemented by observation of the learners or analysis of system data. In general, where these techniques were used, their implementation and delivery was conventional rather than adapted to mobile technologies or mobile learning. If the pilot or trial being evaluated took place in the context of blended learning or classroom delivery this would be appropriate but where the trial or project focussed purely on informal mobile learning, it could be argued to be methodologically flawed and possibly ethically problematic. In fact, most accounts of evaluations did not extend to a discussion of selecting and designing the instruments used.

Questionnaires were often used; interviews, focus groups and observations were used less frequently. Accounts of interviews and focus groups were brief and suggested that the sessions were usually short and probably informal. Statistical analysis and system data were

both used infrequently. In a relative small number of cases, evaluation used and combined several of these different techniques.

Questionnaires

Questionnaires usually used Likert scale fixed responses and the analysis took the form of bar charts or histograms. The samples and populations were usually too small for any form of statistical analysis, though the issue of confidence was usually underplayed and results were sometimes translated into percentages or fractions. The fixed response questions were often supplemented by free-text answers. The analysis of the latter took the form of paraphrase.

Descriptions of the questionnaires were brief; a few were more explicit about both the format and the medium, for example

“..... and, when finished, are asked to fill out a questionnaire about the experience. The questionnaire is composed of 21 statements with which the participants have to express their agreement using 10- and 5-point Likert scales.” (Zancanaro et al., 2004)

and

“Students completed detailed questionnaires about their iPAQ use after four and 16 weeks. They were also asked to keep logbooks recording each use of the iPAQ, their activity, the time spent on the task and the tools they employed.” (Sharpley et al., 2004)

(mainly about the perceived relative popularity of various system functions such as emailer and browser) and

“a questionnaire with short descriptions and screen shots of the various components of the desktop PC and mobile MoreMaths environment was sent by email to the 17 MSc students” (Bull & Reid, 2004)

(using 5-point Likert scale).

Similarly,

“The mobile learning questionnaire is constructed in two parts. The first part, in accordance with mobile learning components, measures the assumed key competencies in using mobile devices in learning activities. The second part measures the learning experiences of the learners who have used the devices.” (Syvanen et al., 2004)

And finally,

“data from an end-of-course questionnaire about student study habits, external access to technology and their attitudes to the XDA (it also covered preferred input methods and feelings about the usefulness of the software and functionality provided)” (Luckin et al., 2004)

These excerpts are the fullest accounts from the literature we reviewed but do not give what social researchers might consider routine details of questionnaire design, piloting, analysis and reliability, and furthermore beg questions of alignment – is a traditional, sedentary, paper-based elicitation technique best suited for capturing perceptions, preferences and feelings about mobile experiences?

Interviews

There are only a handful of accounts of interviews, for example:

“The interviews in the pilot study were semi-structured. The first interview was recorded on a mini-disc, but during the interview the students supported what they were saying by referring to their handheld, so it seemed that it would be more fruitful to film the interviews. As a result, the information saved on the students’ handhelds was also recorded.” (Mifsud, 2004)

but again a sedentary technique was used to explore a mobile experience. The example cited is valuable in using video and artefacts to enrich the data but nevertheless omits to mention the issues of piloting the method or coding, transcribing and analysing the data.

Focus Groups

Again, some accounts were quite sketchy and call into question any conclusions, for example, the focus groups were described as,

“very informal conversations with (an admittedly small number of) students”

and

“engage youngsters between 16-22 years to... take part in a number of student panels to discuss possible applications ...During the panel sessions participants are interviewed ... they are also asked to evaluate customised educational software applications”

and

“As in 2002, visitors to the 2003 tours are asked to fill in a questionnaire about their experience, and focus groups will be conducted with external evaluators.” (Proctor & Burton, 2004)

and

“The pilot tour was taken by 852 visitors who completed evaluation forms recording their experiences. In addition, qualitative focus group studies were conducted by the Susie Fisher Group. The software system used in the trial also logged all uses of the MMT and provided a statistical picture” (Proctor & Burton, 2004)

All these excerpts raise the questions identified previously, namely the lack of explicit reference to the relevant evaluation literature, the undocumented methods and the possible mis-alignment of the methods.

Observation

Observation was also used in a small proportion of projects, as in this example:

“Classroom observations and informal interviews with pupils and teachers were undertaken. The first design of the pilot study opened up for observation not only ‘inside’ the classroom but also ‘outside’ – in the canteen, library and school-yard.” (Mifsud, 2004)

and

“After two weeks of observation, some students were interviewed. Two different forms of interview were used – group or focus interviews and the more

traditional one-to-one interviews. The lessons observed were taken as the starting point of the interview.” (Mifsud, 2004)

Again, these excerpts raise questions about the coding and analysis of non-textual observation data, especially in a non-prescriptive and grounded fashion.

How Findings Are Being Presented

Apart from the usual academic reporting of findings, an evaluation may result in recommendations. Attewell and Savill-Smith (2004) include a number of papers that make recommendations based on evaluation findings, e.g. Vainio and Ahonen (2004) discuss their work in the MOBIlearn project in terms of providing guidelines for adaptive user interface design; Thomas *et al.* put forward design principles for the development and evaluation of mobile educational games, but emphasize their tentative quality:

“While the principles presented here provide a conceptual overview of what could become ‘good practice’ in relation to the development and evaluation of mobile learning games, only a handful of principles have been illustrated... The aim of this paper has been to highlight the need for comprehensive research and evaluation of usability principles and initiate a dialogue in which usability frameworks can be modified, enhanced and validated by the mobile learning community.”

(Thomas *et al.* in Attewell and Savill-Smith 2004, p.179)

The multiplicity of stakeholders in mobile learning pilots and trials, their ‘embeddedness’ in context and the fluidity of terminology and technology make the presentation of findings (but also the presentation of evaluation) an important issue. One role for evaluation specialists, especially where external funding or public money is involved, is placing findings, outcomes and achievements in a wider context.

Ideas for the Future

Having reviewed the state of evaluation and the methods currently being used, it is useful to think about methods that are more closely aligned to the ethos and technologies of mobile learning. When we say ethos, we mean the attributes outlined earlier, specifically the private, informal, spontaneous and 'bite-sized' engagement. Aligning the evaluation means aligning it to these and similar attributes, and of course delivering it using the technology of mobile learning. This is similar to our more general principle that evaluation should be 'built-in' not 'bolted-on'. The following are just obvious examples:

- SMS phones: use fixed format and free format SMS quiz engines for questionnaires; use SMS conferencing for focus groups
- camera-phones: use video and audio responses and picture-messaging to elicit learners' responses - all of these are planned for Wolverhampton University's MELaS Project (www.wlv.ac.uk/celt/melas)
- Voice mobile phone: use VoiceXML or IVR for structured interviews
- PDAs: use quiz or games applications for questionnaires; use voice and video recording for reflection

Conclusions

To draw some of the threads of our discussion together, we have said that developing the concept of a 'good' evaluation is problematic but important. Such a concept should be based on explicit philosophical foundations but our review shows this is not yet usually the case in mobile learning evaluation. The evaluations we examined seem to be based on tacit foundations of 'common-sense' or perhaps on a tacit consensus amongst mobile learning evaluators. It seems to us that many of the trials and pilots themselves rest on a 'common sense' view of learning. In the case of evaluation, this means that there is not always much theoretical justification or coherence to support the selection or use of any given evaluation techniques or methods and a questionable alignment of the evaluation methods and the ethos of mobile learning. These facts jeopardise the credibility of outcomes reported in mobile learning trials and pilots. Mobile learning challenges evaluators to develop evaluation methods and techniques that are sympathetic to the ethos and technologies (and the emerging pedagogies) of mobile learning but our review shows that these are slow to emerge.

Recommendations for good practice can only convincingly rest on evaluation and consequently recommendations for good evaluation can only rest convincingly on an evaluation of evaluations. We recognise the need for continued work on a systematic and comprehensive framework.

References

- Attewell, J. and Savill-Smith, C. (2004) *Learning with mobile devices - research and development - a book of papers*. Learning Skills Development Agency: London.
- Bull, S. and Reid, E. (2004) Individualised Revision Material for Use on a Handheld Computer in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Des Marchais, J.E. (1999) A Delphi Technique To Identify And Evaluate Criteria For Construction Of PBL Problems, *Medical Education* **33**,7, 504 – 508.
- Dewson, S., Eccles, J., Tackey, N. D. and Jackson, A. (2002) *Measuring Soft Outcomes and Distance Travelled: A Review of Current Practice*. Institute for Employment Studies for DfEE: London.
- Kukulka-Hulme, A. and Traxler, J. (2005) *Mobile Learning: A Handbook for Educators and Trainers*. Routledge: London.
- Leach, J., Ahmed, A., Makalima, S., Patel, R., Peters, A. and Powers, T. (2004) Deep Impact: a study of the use of hand-held computers for teacher professional development in primary schools in the Global South, *European Journal of Teacher Education* **27**,1, 5-28.
- Lonsdale, P., Baber, C., Sharples, M. and Arvanitis, T. N. (2004) A context-awareness architecture for facilitating mobile learning, in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Luckin, R., Brewster, D., Pearce, D., Siddons-Corby, R. and du Boulay, B. (2004) SMILE: the Creation of Space for Interaction through Blended Digital Technology in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.

- Mifsud, L. (2004) Learning 2go: Making Reality of the Scenarios? in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Patton, M. Q. (2001) *Qualitative Research and Evaluation Methods*. SAGE Publications: London.
- Proctor, N. and Burton, J. (2004) Tate Modern Multimedia Tour Pilots in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Rugg, G. and McGeorge, P. (1992) Uses of Contrived Knowledge Elicitation Techniques. *Expert Systems*, 9, 3, 149-154.
- Sharples, M., Chan, T., Rudman, P. and Bull, S. (2004) Evaluation of a Mobile Learning Organiser and Concept-Mapping Tool in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Syvanen, A., Pehkonen, M. and Turunen, H. (2004) Fragmentation in Mobile Learning in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Thomas, S., Schott, G. & Kambouri, M. Designing for learning or designing for fun? Setting usability guidelines for mobile educational games, in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Traxler, J. (2002) Evaluating m-learning. *Proceedings of MLEARN 2002, European Workshop on Mobile and Contextual Learning*, 63-64, University of Birmingham, 20-21 June 2002.
- Traxler, J. and Bridges, N. (2004) Mobile Learning - The Ethical and Legal Challenges, *Mobile Learning Anytime Everywhere - Proceedings of MLEARN 2004*, Bracciano, Italy, June 2004.
- Vainio, T. & Ahonen, M. (2003) A Critical Approach to Adaptive User Interface Design. in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.
- Wagner, D.A., Day, B., James, T., Kozma, R.B., Miller, J., and Unwin, T. (2005) *The Impact of ICTs in Education for Development: a Monitoring and Evaluation Handbook*, Washington DC: infoDev.
- Zancanaro, M., Stock, O. and Alfaro, I. (2004) Mobile Cinematic Presentations in a Museum Guide in Attewell, J. and Savill-Smith, C. (Eds) *Learning with Mobile Devices: Research and Development*, London: Learning and Skills Development Agency.