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LITERATURE REVIEW INTO MOBILE LEARNING IN THE UNIVERSITY CONTEXT

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‘The challenge for the educators and technology developers of the future will be to find a way to ensure that this new learning is highly situated, personal, collaborative and long term; in other words, truly learner-centred learning.’

(Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 36)

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1.0. INTRODUCTION

This document represents an extensive survey of the existent literature surrounding the fast-growing field of mobile learning or 'm-learning'. In referencing over 400 recent publications, encompassing conference papers, reports, reviews, and research projects, it presents an indication of the 'state of play' in this emerging discipline.

Undertaken during December 2005 and January 2006, the literature review's primary purpose has been to provide the basis for an academic book on the area: a 'what to' guide considering contemporary changes to learner behaviours, institutional directions, technological developments, and realistic visions for exploiting seamlessly-embedded mobile learning.

This report has been written with the intention of identifying key authors – researchers, practitioners, and theorists – in the field, and recommending directions in which to take the proposed book on the issue. Emerging themes, trends, and nodes of development indicate that the topics of flexibility, engagement, social construction of knowledge, DIY content creation, distributed networking using diverse participants, game-playing, and critical, creative, and collaborative literacies have particular relevance. Importantly, issues of quality assurance, university policy and academic development, as well as access for disadvantaged communities are included.

Significantly, this report expands upon seminal literature reviews undertaken into the area (Attewell & Savill-Smith, 2003; Savill-Smith & Kent, 2003; Mitchell & Savill-Smith, 2004; Naismith, Lonsdale, Vavoula & Sharples, 2004): it now reflects research reports, project updates, and conference papers received in 2005, and has included a section on quality assurance and evaluation which has been hitherto overlooked.

> 'New and emerging pedagogies have harnessed the power of information and communication technologies bringing dramatic change in the educational landscape, transforming the breadth, depth and opportunities for learning.' (Williams & Goldberg, 2005, p. 725)

1.1. Rationale

As recognised by Traxler and Kukulska-Hulme (2005), the changing political, economic and social climate is mandating educational institutions:

- 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;
- to engage with industry and commerce by delivering more training;
- to teach increasing numbers of students in spite of static financial resources. (p. 1)

Research into mobile learning will bring the rewards of placing institutions at the forefront of pedagogical practice, answering student requirements for flexibility and ubiquity: 'anywhere, anytime, and any device' access to information. The question of how prepared institutions are to address the changing landscape is widely pondered (Alexander, 2004a; Wagner, 2005; Naismith, Lonsdale, Vavoula & Sharples, 2004); providing a series of apposite debates and considerations on the issues involved will be a timely contribution to the discipline, and assuredly well received.

Endorsement of this direction is provided by Gay, Stefanone, Grace-Martin, and Hembrooke (2001), as follows:

> 'A priority now is to explore complex, concrete, context-dependent learning settings, to identify how ubiquitous mobile computing tools mediate particular relationships and practices for particular learners and learning communities. Through carefully constructed studies, we can begin to address the challenges posed for the HCI [Human-Computer Interaction] community by the anytime, anyplace nature of mobile and ubiquitous computing technologies.' (p. 273)

1.2. Research Problem Domain Definition

As with any emerging paradigm, the domain of mobile learning has been variously described. When simply defined as 'Learning that arises in the course of person-to-person mobile communication' (Nyíri, 2002, p. 1), mobile learning necessitates examination of pervasive philosophies and practices of education, interpersonal communication, technological implementations, as well as what it is to be 'mobile'. Vavoula and Sharples (2002, p. 152) suggest three ways in which mobility may be conceived: in terms of space, in relation to different pursuits in life, and with respect to time.

> 'Effective mobile learning programs will require new digital communication skills, new pedagogies, and new practices.' (Wagner, 2005, p. 52)

Employing technologies which are portable and personal, embedded, ubiquitous, and networked, mobile learning will provide the potential for rich social interactions in 'real world' contexts, as well as the virtual. Timely consideration of overarching technical, methodological, and educational aspects of mobile learning, as well as social and philosophical dimensions is warranted.

Emphasis is placed on each student having access to and personal interaction with technology in an authentic and appropriate context of use (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 32). There is impetus for educators and instructional designers to consider the following critical success factors with all m-learning implementations: context, mobility, learning over time, informality, and ownership.

The 'what to', rather than the 'how to', guide to academics and their institutions as to the implementation of mobile technologies for learning should seek to define this discipline to offer insight into media and communication, pedagogy, and practice.

1.3. Background to Project

This research will draw on papers presented by the project's primary investigators at the Symposium on Teaching Technology in Higher Education: The 24/7 e-University, Perth, 11-12 October, 2005, and ASCILITE 2005. Titled 'e-learning environments: Generation C: the missing link', the paper by Towers, Smith, and Bruns (2005) is abstracted as follows:

> 'Consideration of the creative industries as a cohesive sector is a relatively recent and contentious construct. The newly coined label 'Generation C' is used as a lens to frame relevant literature that describes knowledge workers who use information and communication technologies (ICT) to create and share content. To support learners in becoming effective creative industries practitioners, a reconsideration of learning designs is proposed that leverages Generation C learners' natural communication

practices and digital skill sets. Curriculum projects from the Creative Industries Faculty (CIF) at Queensland University of Technology (QUT) are presented as illustrations of approaches being employed. Challenges to academic managers include understanding the potential shift and strategically supporting new learning designs.' (p. 1)

The characteristics of the millennial learner, recognised as 'Generation C' (Trendwatching.com, 2005), will be further examined in the current project.

Smith and Brown (2005) consider 'building a culture of learning design' as it relates to online learning in the tertiary curriculum. In a paper presented to the 22nd annual ASCILITE conference in Brisbane in 2005, they develop a Learning Design Framework in which the experience, learning styles, expectations, and perceptions of learners are considered in tandem with the capabilities, goals, experiences and beliefs of teachers, the physical and virtual teaching and learning environment, the knowledge and practices of the discipline, and the scholarship of teaching. The authors propose the adoption of a holistic learner-centred, blended approach to teaching and learning, rather than one solely based on online learning tools themselves.

1.4. Motivation for Study

The various motivations underpinning research and development into the area of mobile learning have been aggregated by John Traxler and Agnes Kukulska-Hulme in 2005. As a meta-consideration, assessment of such motivations provides the motivation of the current study.

In surveying 12 international case studies in their newly published book, *Mobile Learning: A Handbook for Educators and Trainers* (Kukulska-Hulme & Traxler, 2005), the authors' analysis reveals that the rationale provided for employing mobile technologies in teaching and learning relate principally to improving access, exploring changing trends in pedagogy, and alignment with institutional aims. Specific examples are provided under these headings, as follows:

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;
- Exploring whether the time and task management facilities of mobile devices can help students to manage their studies;
- Reducing cultural and communication barriers between staff and students by using channels that students like;
- Wanting to know how wireless/mobile technology alters attitudes, patterns of study, and communication activity among students.

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;

- Harnessing the existing proliferation of mobile phone services and their many users.

The authors' review of the 27 projects documented in the proceedings of MLEARN 2003 (Attewell & Savill-Smith, 2004) indicates similar objectives, with predominance towards the identification of changes in teaching and learning:

Access:
- enabling students to look at course information any time and anywhere;
- 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;
  - a user-friendly m-portal that is powerful and empowering, and encourages active participation by its users;
  - 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;
  - using voice technology to provide rich media content for the user.
- 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;
- to investigate whether an integrated set of learning tools would be useful, which tools would be adopted and the contexts in which the tools would be used;

- development of a service model and new component concepts for lifelong mobile learning.

Furthermore, analysis of the MLEARN 2003 proceedings (Attewell & Savill-Smith, 2004) has also identified certain aims which address 'the future of mobile learning' in generalist terms; namely:

- to find out in which arenas handhelds are used, how and why they are used, and what role they can play;
- what the future take-up of new services and facilities on mobile phones and other technology devices might be;
- to find out whether young adults would be willing to use their phones for literacy and numeracy learning;
- to understand the range of actions and opportunities open to mobile learners, and seek ways of extending this range to support what learners want to do – even if they themselves do not yet know what that is.

1.5. Objectives/Aim of Research

The primary aim of this research is to provide educators and their institutions with an influential 'what to' guide in the area of mobile learning, giving impetus to the implementation of best practice pedagogical programs in the electronic environment. It is intended that the selected authors will provide invaluable insights in order to define the area of mobile learning as it currently exists, and more importantly, how it should exist in the shorter and longer term, and to guide strategic directions as to its implementation.

1.6. Goals/Projected Outcomes

The key outcome of this project is to invite submissions to an edited book on mobile learning. Therefore, the primary output of this literature review is to identify key authors across the domain, and to provide a brief for the writing of the abovementioned text.

The intended structure of the book is currently outlined as follows:

Introduction

Section A: Changing learners, universities and technologies

Chapter 1: Learner Changes
- Generation C
- Produsers
- Digital natives vs. Digital immigrants

Chapter 2: Institutional Changes
- University market (edutainment?)
- Institutional changes
- Changing expectations for education (from learners)
- Required workplace graduate capabilities (in the industry)
- Changing pedagogies (collaborative/ludic/avatar-based roleplaying)

Chapter 3: Technological Changes
- Technologies: wireless, mobile, iPod, DIY media, networked games consoles etc.
- Power relationships changing through technologies
- Infrastructure strategies required of universities

- Blended learning/distributed learning
- Learning quality/litigation/security/governance

Section B: Realistic visions for exploiting seamlessly embedded mobile learning
Chapters organised into aims of using technologies as follows:

- Flexibility
- Engagement
- Social construction of knowledge
- DIY content production
- Critical, creative, and collaborative Literacies
- Distributed networking using diverse participants
- Gameplaying

Section C: Wi(l)der outlook
Two chapters with wilder, more long-term visions

Conclusion

1.7. Significance

Mobile learning represents more than a mere moment of technological fascination: it is clearly identified as the fourth generation of the electronic learning environment (Salmon, 2004), where 'the value of deploying mobile technologies in the service of learning and teaching seems to be both self-evident and unavoidable.' (Wagner, 2005, p. 42)

The current impetus towards mobile learning is identified by Wagner (2005, pp. 49-50): firstly, there are more wireless networks, services, and devices than ever before. Secondly, consumers are demanding better mobile experiences than ever before. Thirdly, people want 'anytime, anywhere' connections more than ever before.

> 'The physical vs. the digital, the sedentary vs. the nomadic – the wireless, mobile, student-owned learning impulse cuts across our institutional sectors, silos, and expertise-propagation structures. How do we respond to such across-the-grain learning? Is this a budding venue for curricular transformation, wedding student interest to institutional practice? How prepared are we in higher education to cope with, or take advantage of, these deeply rooted differences? Should our physically sedentary campuses embrace the digitally nomadic swarms of arriving students?' (Alexander, 2004a, p. 34)

It is widely recognised that in the current environment where mobile infrastructure reaching the point of being pervasive, educators need to adapt from a role as transmitters of knowledge to guiders of learning resources. In addition, technology developers need to respond to concerns of security and privacy while designing devices and services that learners both want and will pay for. (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 36)

In addressing these issues, the proposed book will find particular resonance for current practitioners, theorists, and administrators.

1.8. Scope

Topic areas embraced by this research will contribute to Section B of the outlined book structure: realistic visions for exploiting seamlessly-embedded mobile learning. They currently encompass the following areas: flexibility, engagement, social construction of knowledge, DIY content production, distributed networking using diverse participants, game-playing, and critical, creative, and collaborative literacies. Questions of quality assurance and university policy development have been included, as well as provision for disadvantaged students to access mobile materials.

In addition, whilst the focus is not placed on mobile technology *per se*, but rather on how it is employed in – and importantly beyond – the classroom context, a section considering implementation issues has been added, as well as a brief consideration of existing ICT options.

1.9. Limitations

This literature review has considered the broadest possible sources of published research on the topic of mobile and online teaching and learning. As with any environmental scan, it endeavours to be extensive, but, owing to constrictions of time and resources, cannot be exhaustive. A notable limitation which must be acknowledged at this time has been the lack of access to the new publication of Kukulksa-Hulme and Traxler (2005) *Mobile Learning: A Handbook for Educators and Trainers*. The book is on a rush order through the QUT library, and we should expect to see it in the next month.

This report reflects the fact that there are multiple definitions of key terms which are at times difficult to reconcile. Where appropriate, all aspects to a term are taken into consideration, whether they compete with each other or not.

1.10. Research Participants

This research project, directed by the primary researchers identified in section 1.10.1., will embrace key authors (researchers, theorists, and practitioners) in the areas identified in section 2.

1.10.1. Primary Participants

The primary investigators in the current project are Professor Stephen Towers, Director of Academic Programs at the Creative Industries Faculty (CIF), Queensland University of Technology (QUT), Jude Smith, Lecturer in Dance and Learning and Teaching Consultant for CIF, QUT, and Dr Axel Bruns, Lecturer in Media and Communication, CIF, QUT.

Associate Professor Terry Flew, Head of the Media and Communications Discipline, CIF, QUT, may be asked to contribute to the intended Chapter 2: Institutional Changes.

The project has gained sponsorship from Neil Thelander, Director of Information Technology Services (ITS) at QUT.

This literature review has been completed by Rachel Cobcroft, PhD Candidate in the Institute for Creative Industries and Innovation (iCi) at QUT.

1.10.2. Key Stakeholders

Key stakeholders to any m-learning implementation are clearly the learners themselves, lecturing staff, system designers and the technical staff who implement them, and device vendors, along with the university administration who oversees the project. In the theoretical model of m-learning proposed by Barker, Krull, and Mallinson (2005), discussed in section 4.9, primary stakeholders include learners, their parents, teachers, system designers, device vendors, and support staff.

When considering the contributions to the book, the various opinions and perspectives of different stakeholders should be taken into account.

1.11. Structure of Report

This literature review, considering the current and future practices of mobile learning in the tertiary sector, is structured as follows:

The project scope and terms of reference have been introduced in section 1, along with the identification of primary researchers and key stakeholders.

The main body of the literature review is presented in section 2. The concept of mobile learning is explored in section 2.1, in how it relates to the e-learning discipline. Specific areas of interest to the primary investigators – namely, flexibility, engagement, DIY content creation, the critical, creative, collaborative, and communicative literacies, distributed networking with diverse participants, and game playing – are considered in sections 2.2 to 2.7.

Section 3 explores the pedagogical underpinnings to m-learning, examining the constitution of best practice, and the social construction of knowledge. Associated learning theories, such as Activity Theory and Conversation Theory, are introduced. The specific traits of learners belonging to Generation C are briefly described in section 3.11.

Section 4 considers the specific technologies able to be implemented as part of the m-learning strategy. These include iPods and PDAs, along with mobile phones and palmtop computers. Guidance to the implementation of mobile learning programs is provided in section 4.8, with critical success factors identified in section 4.9. Evaluation and Quality Assurance considerations are introduced in the context of university policy development in sections 4.10 and 4.11. Programs for academic development are advocated in section 4.12.

Bibliographic data is provided in section 5. This includes an identification of sources such as research institutions (section 5.2), primary journals (section 5.3), key conferences (section 5.5), and projects (section 5.6). Significant contributors to the field of mobile learning are identified in section 5.4.

The report concludes in section 6, offering recommendations in section 6.1, and identifying areas to be addressed by future research in section 6.2. References and a glossary are provided in sections 7 and 8, respectively.

2.0. LITERATURE REVIEW

2.1. From e-Learning to m-Learning: Making Successful Transitions

> 'The success of mobile learning will ultimately revolve around a mosaic of rich converged experiences. These experiences will rest, in turn, on a foundation of converged network and device technologies, wireless services, rights management, content management, search management, and transactional processing power.' (Wagner, 2005, p. 52)

The vision of mobile learning presented by the majority of authors currently writing in the field is that it seeks to enable 'anywhere, anytime, and any device' portable and personalised learning; it will facilitate communication, collaboration, and creativity among participants in authentic and appropriate contexts of use. In some respects, this is perceived as a revolution of 'just-in-time' and 'just-for-me' information delivery; however, the employment of mobile devices will be far from a panacea for the problems currently faced in education unless implementations of m-learning take heed of lessons 'e-learned' (Wagner, 2005, p. 47).

As with the implementation of any innovative scheme, significant technical and administrative challenges will be encountered. These will be met along with a more ill-defined challenge: 'How can the use of mobile technologies help today's educators to embrace a truly learner-centred approach to learning?' (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 32) The book proposed by this project will seek to answer such questions: apposite pedagogical principles, issues in human-computer interaction, and technological themes will undoubtedly be addressed.

Represented in a simple diagrammatic fashion, the transition from e-learning to m-learning is one as expressed in Figures 1 and 2.

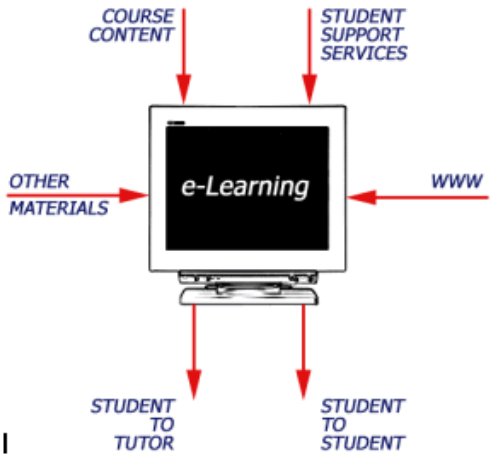

Figure 1: Wired Virtual Learning Environment of Today
(http://learning.ericsson.net/mlearning2/project_one/elearnmlearn.html, 19/01/2006)

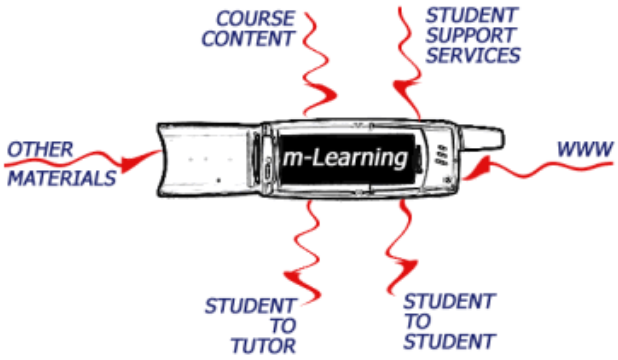

Figure 2: Wireless Virtual Learning Environment of Tomorrow
(http://learning.ericsson.net/mlearning2/project_one/elearnmlearn.html, 19/01/2006)

The transition from e-learning to m-learning has been one marked by many authors (Laouris & Eteokleous, 2005; Nyíri, 2002, 2005; Mostakhdemin-Hosseini & Tuimala, 2005; Georgiev, Georgieva & Smrikarov, 2004; *inter alia*), and most helpfully Sharma and Kitchens (2004). Sharma and Kitchens (2004) note that the transfer from the e-learning to m-learning revolution has been accompanied by a change in terminology: 'multimedia' now gives way to 'learning object', 'interactive' to 'spontaneous', as represented in Figure 3.

e-learning	**m-learning**
Computer	Mobile
Bandwidth	GPRS, G3, Bluetooth
Multimedia	Objects
Interactive	Spontaneous
Hyperlinked	Connected
Collaborative	Networked
Media-rich	Lightweight
Distance learning	Situated learning
More formal	Informal
Simulated situation	Realistic situation
Hyperlearning	Constructivism, situationism, collaborative

Figure 3: Terminology comparisons between e-learning and m-learning (Sharma & Kitchens, 2004, as adapted by Laouris & Eteokleous, 2005, p. 3)

The primary pedagogical differences between the two disciplines are the distinction between more text- and graphics-based instructions to more voice-, graphics-, and animation-based instructions. Where learning previously occurred in front of a computer terminal, in the classroom, laboratory, or at home, it is now enabled to occur in the field, or at any location where the mobile device is fully functional (Sharma & Kitchens, 2004).

Distinctions between modes of communication among the various actors involved in mobile learning may be represented as in Figure 4:

Instructor to Student Communication	
Time-delayed (students need to check e-mails or Web sites)	Instant delivery of e-mail or SMS
Passive communication	Instant communication
Asynchronous	Synchronous
Scheduled	Spontaneous
Student to Student Communication	

Face-to-face	Flexible
Audio-teleconference common	Audio- and video-conference possible
e-mail to e-mail	24/7 instantaneous
Private location	No geographic boundaries
Travel time to reach Internet site	No travel time since wireless connectivity
Dedicated time for group meetings	Flexible timings on 24/7 basis
Poor communication due to group consciousness	Rich communication due to one-to-one communication, reduced inhibitions

Figure 4: Differences between e- and m-learning environments with respect to modes of communication between actors (Sharma & Kitchens, 2004, as adapted by Laouris & Eteokleous, 2005, p. 3)

Finally, differences between e- and m-learning environments with respect to methods of evaluation have been presented as follows, in Figure 5:

Feedback to Students	
1-to-1 basis possible	1-to-1 basis possible
Asynchronous and at times delayed	Both asynchronous and synchronous
Mass/standardized instruction	Customized instruction
Benchmark-based grading	Performance & improvement-based grading
Simulations & lab-based experiments	Real-life cases and on the site experiments
Paper-based	Less paper, less printing, lower cost

Figure 5: Differences between e- and m-learning environments with respect to methods of evaluation (Sharma & Kitchens, 2004, as adapted by Laouris & Eteokleous, 2005, p. 3)

As observed by Mellow (2005), with reference to Valentine (2004), the MLEARN 2004 conference held in Rome drew three conclusions about m-learning and its perceived relation to e-learning; namely:

- m-Learning is a sub-set of e-Learning – as such it needs to be considered within a blended learning strategy in the same way that any education institution or corporate training department needs to view all other learning delivery methods;
- m-Learning is a means to enhance the broader learning experience, not (as we predicted for e-Learning) a primary method for delivering courses/distance Learning;
- m-Learning is a powerful method for engaging learners on their own terms especially for those who could be classed as non-traditional learners or for those groups of students who cannot participate in classroom learning for whatever reason. (p. 471)

The appropriate practices of m-Learning have many recognised benefits, documented by Attewell (2005), amongst others:

- ✓ Mobile learning helps learners to improve their literacy and numeracy skills and to recognise their existing abilities;
- ✓ Mobile learning can be used to encourage both independent and collaborative learning experiences;
- ✓ Mobile learning helps learners to identify areas where they need assistance and support;
- ✓ Mobile learning helps to combat resistance to the use of ICT and can help bridge the gap between mobile phone literacy and ICT literacy;
- ✓ Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners;
- ✓ Mobile learning helps learners to remain more focused for longer periods;
- ✓ Mobile learning helps to raise self-esteem;
- ✓ Mobile learning helps to raise self-confidence. (pp. 13-5)

The convergence between learning and technology may be represented by the following terms:

New Learning	**New Technology**
Personalised	Personal
Learner-centred	User-centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

Figure 6: New Learning and Technology Terms (Sharples, Taylor & Vavoula, 2005, p. 3)

Definitions of e- and m-learning are to be found in the Glossary in section 8.0, and a further enunciation of mobile learning by Laouris and Eteokleous (2005) in Appendix A.

Specific Areas of M-Learning Development

The following sections represent investigations into current thinking in the emerging areas of interest to the field of mobile learning.

2.2. Flexibility

The ideal of 'always-on learning, accessible to the masses, but tailored to the individual' (Thomas, 2005, p. 5) is presented as the goal of pervasive learning environments in the electronic age, as described at PerCom: the annual IEEE International Conference on Pervasive Computing and Communications. Authors Thomas (2005) and Keil-Slawik, Hampel, and Eßman (2005) identify the benefits of ubiquitous computing, reconsidering the interactivity and responsiveness of educational architectures and introducing the integration of learning objects as the necessary starting point for success.

Extending the concepts of collaborative learning, cooperative learning, constructivism, information-rich learning environments, self-organised learning, adaptive learning, and multimodal learning, *inter alia*, pervasive learning defines the potential of the 'mobile' moment in terms of the creation of new knowledge spaces. Presented as 'anywhere, anytime' learning, pervasive learning is created through a network of devices, people, and situations that allow complex learning experiences to play out:

> 'At its core, pervasive learning is about using the technology that a learner has at hand to create relevant and meaningful learning situations, that a learner authors himself, in a location that the learner finds meaningful and relevant.' (Thomas, 2005, p.1)

Built on notions of community, autonomy, locationality, and relationality, pervasive learning offers flexibility to learners in the following terms:

- *Community*: Learners are not "taught" by one teacher. They are educated by a learning community (of which they play a central part), and are educating others in the community as well;
- *Autonomy*: Learners are freed from power politics that see one central authority figure or authority structure directing the course of learning. They become comfortable with the knowledge that in the world there is no correct "answer," but that there are many variations and possibilities and learning feedback comes from a variety of sources;
- *Locationality*: Learning is not just for the classroom but for the world outside classroom doors, of which the classroom is a part, a world where learning has no "on/off" switch;
- *Relationality*: Because learners learn within their own personal environments they can understand better the implications of what they are learning and can construct ways to relate this knowledge in their lives. (Thomas, 2005, p. 2)

In terms of location, for example, mobile learners should have the option of choosing when and where they learn. This accrues the benefit of allowing learners to translate 'textbook' experience into knowledge apposite to the 'real world'.

Self-regulated learning, as discussed by Shih, Chang, Chen, and Wang (2005), allows the learner to identify his or her own optimal way for learning, where appropriate scaffolding (Bruner, 1983) supports the learner in their chosen environment and allows for continual enhancement of performance. This is seen as being achieved through the four-fold provision of learning schedules, materials, scenarios, and quality (p. 30). The self-regulated system thus provides those engaging in education with a portable and personalised learning environment, thereby cultivating a self-motivated, self-directed, and self-regulated learner (p. 34).

Notions of efficient and effective learning in blended learning environments are examined by Rachael Field (2005) from the Faculty of Law at the Queensland University of Technology. With the acknowledgment that 'contemporary students increasingly appear to require flexibility in the conditions and requirements of their learning environment' (Field, 2005, p. 208), the choice of when, where, and how to learn becomes paramount to the student in the context of their complex life 'matrices'.

Efficiency in the learning process indicates offering flexibility to students in the determination of the conditions and circumstance of their learning (Field, 2005). Teaching models which integrate online learning in a 24x7 framework (Bender, 2003, p. 65; Salmon, 2000, p. 17), or provide the student with 'own time' study options and assessment choices, show significant efficiency benefits (Field, 2005). Adding mobility to the classroom setting goes some way to achieving this aim. Use of asynchronous discussion tools, where the format of interaction facilitates contributions in a student's own time and at their own pace (Salmon, 2004), achieves effectiveness and efficiency in the learning process (Field, 2005), and aspires to egalitarianism (Bender, 2003, p. 65). The positive attitudinal impact of such interactions should extend into the achievement of successful learning outcomes (Field, 2005, p. 208).

The portability of devices coupled with wireless connectivity is identified by Barker, Krull, and Mallinson (2005) as bringing significant benefits to learners in terms of flexibility of access to learning materials. Providing students with the ability to go beyond the confines of the classroom accrues the benefit of interacting in the 'real world', and further supports enhanced interaction with peers. According to Perry (2003), classes involving ICTs are too often taught in specialised rooms, which has the disadvantage of making the learning environment overly artificial. Moreover, teachers are often confronted with technology they use infrequently in such environments, placing further constraints on interaction. There is thus a need to 'grab' contextualised learning opportunities whenever and wherever they arise (Perry, 2003).

Mobile intelligent tutoring systems (ITS) are considered by Bull, Cui, McEnvoy, Reid, and Yang (2004) as combining the flexibility of individualised tutoring with the flexibility of learning in a variety of locations. In their paper delivered at IEEE WMTE 2004, the authors consider diverse learner models across the mobile adaptive learning environments, identifying pertinent issues and attributes which have bearing in a mobile learning context. Four systems are presented as exemplars, and findings demonstrate that location is relevant to the content of an interaction as well as to its ultimate success.

2.2.1. Mobility, Disability, and Special Needs

Given the flexibility which mobile devices afford, the communication and collaboration which they facilitate, and enhancement of literacies which they initiate, mobile learning adopts a prime position to address mobility, disability, and special need issues. Savill-Smith and Kent (2003) note that laptop computers have been employed in the support of special needs students in the following areas:

- *Deafness*: A third-generation mobile device, known as WISDOM, designed for deaf users has been implemented to recognise continuous sign-language sentences in German, and allows person-to-person live communication over distance in three-dimensional sign language (Bauer & Kraiss, n.d.);
- *Cognitive impairment*: Carmien (2002) documents a prompting system, known as MAPS, to assist cognitively impaired users with shopping and bus trips;
- *As an adjunct to cognitive behaviour therapy for panic disorders*: Newman *et al.* (1996) describe the use of a palmtop computer for a user experiencing a panic attack, whereby a series of questions appears on screen to slow down the user's breathing and to help them to reflect on their fears;
- *Severe developmental disabilities*: Davies *et al.* (2002a, 2002b) describe schedule-prompting visual assistant software, including audio support, for a palmtop PC to assist people in the performance of their vocational and daily duties with increased accuracy. In aiding completion of tasks, user independence and self-confidence was increased. A similar project known as VICAID has been described by Furniss *et al.* (2001), whereby a palmtop-based tool assists workers with task scheduling, which is useful for those with attentional difficulties;
- *Motor impairment*: Myers (2000) describes a system focusing on aiding in muscular dystrophy, where movement is difficulty and the handheld function of is useful;
- *Language translation*: A program in India employing a handheld computer, the 'Simputer', reads aloud Web pages written in English and translates them to three Indian languages – Hindi, Kannada, and Tamil (Singh, 2002). The project was designed to connect people living in rural villages to the Internet, via phone kiosks. A pilot study has been commenced to broadcast adult education and basic literacy packages by satellite for downloading to central locations accessible by the Simputer;
- *Language tuition*: Prototype systems have also been developed for learning Mandarin (Kumagai, 2002), Kanji (Fukuda *et al.*, 1995), and the pronunciation of Indonesian (Nelson, 1998).

Support of disadvantaged youth between 16–24 who are disengaged from full-time education and training has been considered in depth in the m-learning project, described in section 5.6.2, as documented by Attewell and Savill-Smith (2003), Attewell and Webster (2004), and Attewell (2005), in considering issues of social inclusion and engagement in mobile learning. In an independent evaluation of the initiative (Attewell, 2005), the objectives of m-learning project have been described as

> 'Large and complex, developing, exploiting and integrating a range of innovative technologies and devices, and delivering mobile learning to hard-to-reach youngsters who were economically and educationally marginal. The project culminated in large-scale trials, probably the largest

to date, across a diverse set of situations, organisations and of learners.' (p. 1)

Mobile learning infrastructure development in developing countries has been the focus of mLearn 2005, held in Cape Town, South Africa, between 25 – 28 October, 2005. In a paper presented by Barker, Krull, and Mallison (2005), the authors investigate the use of wireless technologies in education with particular reference to the potential for m-learning in developing countries. Considerations examined include current limitations of the devices, safety and security concerns, and cost issues. Further contributions are to be found in the proceedings.

2.3. Engagement

In discussing favourable conditions for effective and efficient learning in a blended environment, Rachael Field (2005) refers to Ramsden's (1992) first principle of effective teaching; namely, ensuring student interest, which includes making the learning of unit material a 'pleasure' for students (Ramsden, 1992, p. 96). The second principle enunciated by Ramsden is equally enduring: that of demonstrating concern and respect for students and student learning (Ramsden, 1992, p. 97). As Field (2005) notes:

> 'Achieving effective learning in this way requires a student-centred, outcome-focused approach that encourages high-level cognitive engagement with unit content and concepts. It is also requisite that students are motivated to learn through the teaching process (Wlodkowski, 1999).' (Field, 2005, p. 207)

In her exemplary consideration of Ramsden's (1992) further pedagogical principles, such as the creation of a learning environment that encourages independence, control, and active engagement (Ramsden 1992, p. 101), Field (2005) creates the context for the effective and efficient implementation of blended learning environments. Providing a focus on discursive, active, and collaborative learning aimed to engage students, Field (2005) endorses the complement of face-to-face environments enhanced by mobile devices.

As reported by Barker, Krull, and Mallison (2005), the impacts of wireless technologies on education clearly encompass issues of motivation. According to Vahey and Crawford (2003), educators report that learners using handheld wireless technologies demonstrate increased autonomy in learning, manifesting improved self-directedness and initiative in finding diverse ways to employ handheld devices which are beneficial to learning. As a further endorsement, Perry (2003) notes that Becta project schools, as endorsed by the British Educational Communications and Technology Agency, are unanimous that their students were excited and highly motivated upon the commencement of using handheld devices. Belt (2001) documents that the implementation of wireless technologies in the educational milieu increases learner participation, with students appearing more engaged in the learning process.

Whilst Belt (2001) and Perry (2003) concur that providing wireless technologies augments students' enthusiasm, the noted increase in learner participation and enthusiasm may be partially explained by the novelty factor of having a new technology with which to play. Belt (2001) explains that once the novelty has worn off, students come to see mobile devices as working tools.

The observation as to the effect of novelty has also been noted by Attewell and Webster (2004), in their exploration of engaging and supporting mobile learners. Examining indications of change in attitudes amongst students, the researchers have been particularly interested to find out whether some of the participants in their m-learning research later register to take part in further e-learning activities. Interviews with student mentors revealed that there was a belief that 'the devices are good tools to engage non-traditional learners; they remove the formality, which can be the most frightening aspect for those who have not engaged with learning' (p. 18). Educators reported that the use of mobile devices improved retention of learners in their course.

Issues of student retention through the use of mobile technologies have been partially addressed by Stone (2004), where the implementation of the Short Messaging System (SMS) has been identified as a form of 'mobile scaffolding' to

support first-year university students. Despite the low response-rate to an email questionnaire, the findings of Stone's (2004) study indicate that universities may be able to use mobile technologies for administrative and pastoral services. In this instance, students found SMS-ed reminders of assessment deadlines to be of the greatest use. The study advocated using a blended approach: when considering novel support mechanisms, particularly where technologies may be thought of as able to replace, rather than complement, existing modes of communication, it is important to consider a variety of communication techniques (Stone, 2004, p. 185). The study also emphasised that student concerns surrounding issues of security and trust cannot be downplayed (Carroll & Hartnell-Young, 2004; Sørensen, 2004).

The creation of a community of practice through collaborative learning, supporting the cohesive, social constructivist learning styles in the use of mobile devices, has been addressed by Colley and Stead (2004) in their MLearn 2004 paper titled 'Mobile learning = collaboration'. The use of a shared online space, mediaBoard, shows that learners feel involved and able to use technology as a facilitator for their own creative ideas (Lave & Wenger, 1991; Wenger, 1998ab). Results indicate that learners' affective and social needs are addressed by 'engaging the imagination and promoting exploration and creativity within a non-threatening environment' (Colley & Stead, 2004, p. 58).

Tailoring material to the individual learner for delivery on handheld computers has been canvassed by Bull and Reid (2003), who propose the implementation of an adaptive learning environment for use on a desktop PC synchronised with a handheld device. Revision material sent to the student for viewing on the handheld is tailored specifically to that individual, and has the benefit of being available for study at times and in locations where it may not normally be convenient for the student to study, but where they 'might nevertheless welcome this opportunity' (p. 38).

The concept of self-regulated learning in the electronic and mobile domain has been addressed by Shih, Chang, Chen and Wang (2005). Adopting scaffolding theory (Bruner, 1983) in the establishment of mutually-acceptable and achievable goals for student and teacher alike, the paper proposes a self-regulated system based on a 'mobile, portable, and personalized learning environment' (p. 34) where the learner identifies their optimal learning style, employing wireless technology to cultivate a 'self-motivated, self-directed, and self-regulated learner' (p. 34).

The social issues surrounding the implementation of palmtop computers have been documented by Savill-Smith and Kent (2003). Referring to Strom and Strom's (2002) study, in which high school teachers employed PDAs to record students' conduct, the authors note improved learning conditions for students in relation to their awareness, establishment and maintenance of peer relationships, amount of time spent on-task, and ability for self-regulation. Key to this approach was the rapid involvement of parents in correcting inappropriate behaviour and reinforcing good behaviour, when reports of student conduct are received via pager.

The development of a handheld computer game developed by Rodríguez, Nussbaum, Zurita, Rosas, and Lagos (2001) targeted to young pupils of 6-7 years, has been reported to improve motivation, with students displaying high levels of attention and concentration. Another study involving 12-year olds who had shown signs of drug abuse and other social problems, demonstrated that the use of these handheld games improved their voluntary attendance at class (Rodríguez, Nussbaum, Zuria, Rosas & Lagos, 2001).

Exploring e-learning as an associated domain, it has been reported that motivating students can be challenging when moving from traditional classrooms to Web-Based Training (WBT) (Firmin & Miller, 2005). WBT remains difficult for students, raising technical hurdles and complicating social interaction, given that the cues and camaraderie of classroom training are absent (Horton, 2000). Beffa-Negrini, Cohen, and Miller (2002) report that student motivation in online domains can vary depending on content complexity and a lack of union between content and student needs. Maintaining motivation at the outset of online learning is critical, where students often have to respond to technical glitches (Salmon, 2000).

In an experiment with the implementation of an animated pedagogical agent for pharmacology students, Jones, Larson, Weaver, and Caliph (2005) note that maintaining student motivation in online learning requires a range of activities, both to cater to different learning styles (see for example, Felder & Soloman, 1999; Fleming, 1998), but also to add interest to what can be an unexciting and isolating experience (Weaver & Nair, 2005).

2.4. DIY, Learner-Created Content

As understood by Thomas (2005), learner-created content refers not solely to the creation of text, images, videos, music, or hyperlinks, but also to the construction of a locational and situational framework for where and when learning will occur: 'There is a time and place for learning; it should be a learner's time and place' (p. 3).

Choice afforded by mobile technologies provides the opportunity for the development of personalised and individualised learning environments. This stands in contrast to traditional teaching scenarios, where a learner's autonomy was rarely considered: Grabinger and Dunlap (1995) have noted that

> 'We treat students passively… rarely giving them the opportunity to take responsibility for their own learning, to explore ideas of their own choosing, to collaborate with one another… to make valuable contributions to the learning of others. They do not take charge of their own learning…'

In shifting the locus of control to the learner, the 'how, what, and why' of learning is determined by the student, rather than being dictated by the traditional authority figure, such as a teacher, or authority structure, such as a school or university. Providing autonomy through technology allows involvement at the learner's pace, which may be 'just in time' and 'just for me'.

In keeping with this, Thomas (2005) adheres to the principle of placing emphasis on content ownership: 'let them author, and they will stay' (p. 2). With learners creating their own content according to their own context, they have the ability to modify and make changes which will directly impact on their world. This sense of ownership is crucial to motivation and the successful outcome of the learning experience.

Allowing students to engage in the domain of professional practice, to 'teach themselves and others around them – and be alarmingly competent while they're at it, producing tangible results' (Thomas, 2005, p. 2) has notable proponents. Bradburne and Wake (1991) have argued for learners to be generators rather than merely 'receive' education. Buckingham (2000) endorses a new media literacy where learners do the composing, whilst Brandt, Hillgren, and Bjorgvinsson (2003) chronicle the process of self-produced video to augment peer-to-peer learning in a hospital intensive care unit, where nurses teach themselves critical procedures which may mark the difference between life and death.

Weiss (2004) considers the benefits of using mobile phones and pocket PCs for creating, delivering, and retrieving content on the fly, based on mobile Web browsers, in his paper presented at MLearn 2004. Presenting the CHIMER Project (http://www.chimer.org/), Weiss demonstrates the development and implementation of mobile technologies to report in real-time on cultural heritage environments in Spain, Germany, the Czech Republic, Lithuania, and Holland. The project's infrastructure is based on using GPS, vector maps, satellite photos, mobile phones supporting Web browsers, GPRS networks, and an application that updates existing e-guides located at the main CHIMER site with new GIS information from the field. Illustrating how to create, upload, and retrieve information using an application based on a mobile phone browser with a roaming GPRS connection, Weiss allowed conference participants to create, upload, and retrieve their own content on the fly.

2.5. Critical, Creative, Collaborative, and Communicative Literacies

The following sections address the specific concepts of critical, creative, and collaborative literacies, and make mention of the importance of communication in this mix.

2.5.1. Critical

When considering the manifold rewards of learning in the electronic environment, Williams and Goldberg (2005) reflect that 'Importantly, as less time is spent in didactic content transmission, there is more time for reflection and critical analysis – important, lifelong learning skills.' (p. 727)

The constructivist principle of reflection is considered by Smyth (2004), in terms of employing mobile devices as tools to allow learners to build their own understandings of a topic, and thus to encourage deep learning and critical thinking. A proposed design for learning incorporates reflection in terms of the distribution and completion of worksheets based on a range of semantic organisation tools including concept-mapping, designed to assist learners in analysis and organisation of information. NESTA Futurelab (2004) demonstrates that the effectiveness of electronic tools in these scenarios is further enhanced when learners are placed in pairs or groups.

Importantly, the design discussed by Smyth (2004) incorporates the idea that learners upload their reflective and learning contributions to a collaborative area on an online learning portal, for use and enhancement by others. The collaborative aspect of the design is thus derived from learners sharing worksheets and conducting peer reviews on each other's ideas, innovations, and implementations. In addition, the capabilities of both the PC and mobile device are leveraged, and as Bransford, Brown, and Cocking (1999) note, this may result in the gestalt phenomenon that an 'intellectual partnership with the computer in that the whole of the learning becomes greater than the sum of the parts.'

The role of reflective logs is considered by Savill-Smith and Kent (2003), who acknowledge the potential for palmtops to be used in clinical medical settings to record students' observations in a professional context. Such observations are able to be fed back to tutors for formal feedback and assessment, but also importantly, to serve as the basis of the students' own reflection on their learning. Naturally, this relies on the portability of the device in being with the students on all occasions.

Savill-Smith and Kent (2003) remark that the annotation of reflective diaries may have a parallel with the now-popular practice of blogging, which consists of the frequent publication of personal thoughts and opinions on the Internet. A paper by Lester (2003) examines the phenomenon of blogging in a community of users of a wireless networked handheld device, here a type of smart phone:

> '[I]t appears that by having ubiquitous mobile data communication devices and a successful communal blog, it is possible to create an ideal environment within which a smart mob can grow into a goal-oriented mobile community of practice. … The increasing popularity of communal blogs, coupled with more sophisticated ubiquitous mobile communication devices … will most likely make this interesting social phenomenon more common in the future. A future opportunity will be the deliberate

cultivation of this phenomenon, as it has the ability to create incredibly effective and creative goal-oriented teams of mobile individuals.'

The findings of Crippen and Brooks (2000) involve a trial in which supervisors of student teachers used palmtops for observing students in a classroom context. Having the ability to email these observations between observer and student increased the interactions from five to ten times as that which had been experienced in pre-Internet scenarios, and allowed for immediate follow-up discussions and reflections. Keeping a journal was also found to help student teachers reflect on their learning experiences and to increase their rapport with the tutors and their computer proficiency (p. 22).

The key writings on critical thinking and technology have come in NESTA Futurelab's Report 2 on Thinking Skills, Technology and Learning (Wegerif, 2002). With the report, Wegerif (2002) proposes:

- To clarify what is meant by thinking skills and their relationship to technology;
- To identify the role of ICT in promoting thinking skills;
- To produce guidelines for the development of digital learning resources to support the teaching and learning of thinking skills;
- To evaluate the general direction of research in this area and how this should inform educational practice. (p. 1)

As is seen in section 2.5.2, definitions of 'creativity' abound. So too, notions of critical, higher-order thinking carry complexity. In the National Curriculum for England (DfES, 2002, http://www.nc.uk.net/learn_think.html), 'thinking skills' are divided into the following areas:

- *Information-processing skills*: These enable pupils to locate and collect relevant information, to sort, classify, sequence, compare and contrast, and to analyse part/whole relationships.
- *Reasoning skills*: These enable pupils to give reasons for opinions and actions, to draw inferences and make deductions, to use precise language to explain what they think, and to make judgements and decisions informed by reasons or evidence.
- *Enquiry skills*: These enable pupils to ask relevant questions, to pose and define problems, to plan what to do and how to research, to predict outcomes and anticipate consequences, and to test conclusions and improve ideas.
- *Creative thinking skills*: These enable pupils to generate and extend ideas, to suggest hypotheses, to apply imagination, and to look for alternative innovative outcomes.
- *Evaluation skills*: These enable pupils to evaluate information, to judge the value of what they read, hear and do, to develop criteria for judging the value of their own and others' work or ideas, and to have confidence in their judgements.

Whilst these definitions are praised for their brevity and clarity, the definitive definition of critical thinking is published in *The Delphi Report* (Facione, 1990). The shortest form of the definition is given below:

> 'We understand critical thinking to be purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. CT is essential as a tool of inquiry. As such, CT is a liberating force in education and a powerful resource in one's personal and civic life. While not synonymous with good thinking, CT is a pervasive and self-rectifying human phenomenon. The ideal critical thinker is habitually inquisitive,

> well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. Thus, educating good critical thinkers means working toward this ideal. It combines developing CT skills with nurturing those dispositions which consistently yield useful insights and which are the basis of a rational and democratic society.' (Facione, 1990)

Exploring how best to achieve higher order thinking, defined thus, the author categorises three main ways of conceptualising ICTs in relation to the teaching of thinking skills; namely: as tutor or teaching machine; as providing 'mindtools'; and as a support for learning conversations (Facione, 1990, p. 3).

> 'Effective learning situations allow learners to explore possibilities, to make their own mistakes, to examine shreds of evidence, to tread carefully through an interplay of psychological factors, to learn to deal with politics and economics that are dosed out in varying quantities, to analyze patterns that emerge, to link disparities, and make connections. Pervasive learning situations are well-situated to allow learners to experience complexity and to reflect, explicitly and implicitly, on their experiences.' (Thomas, 2005, p. 3)

In reflecting on the critical capabilities of students in the mobile generation, Wagner (2005) asks whether the brevity of expression, characteristic of wireless communication, will trump depth of knowledge. 'Will the "filter generation" learn how to think critically and communicate effectively while using today's and tomorrow's digital tools?' (p. 42) The answer to such a question clearly remains to be seen.

2.5.2. Creative

> 'The designs of new communications technologies for creative interactions are presenting challenges to expectations of traditional classroom settings in terms of spaces, time, portability, connectivity and flexibility for individuals and communities. Learners can engage in a range of activities, from using interactive whiteboards and wireless portable computers, to working together in virtual spaces to exchange and build ideas and artefacts.'
> (Loveless, 2002, p. 4)

The primary statement on creativity as facilitated and enhanced by ICTs has been compiled by A.M. Loveless (2002) as the NESTA Futurelab Report on Creativity, New Technologies and Learning. This report has the intention of providing:

1. A sound theoretical and empirically informed basis for prototype development of digital learning resources to support the teaching and learning of creativity;
2. A sound theoretical and empirically informed basis for informing policy on the teaching and learning of creativity;
3. A basis for communication between the educational research community and the commercial sector on the subject of the teaching and learning of creativity with ICT. (Loveless, 2002, p. 1)

The impetus towards creativity, best captured by Craft (1999) as 'an essential life skill, which needs to be fostered by the education system(s) from the early years onward' (p. 137), is taken up by the British National Advisory Committee on Creative and Cultural Education (NACCCE) in their report 'All Our Futures' (NACCCE, 1999). Defining 'creativity' as 'imaginative activity fashioned so as to produce outcomes that are both original and of value' (NACCCE, 1999, p. 29), five key characteristics of the creative process and facility are expressed:

- *Using imagination* – the process of imagining, supposing and generating ideas which are original, providing an alternative to the expected, the conventional, or the routine
- *A fashioning process* – the active and deliberate focus of attention and skills in order to shape, refine and manage an idea
- *Pursuing purpose* – the application of imagination to produce tangible outcomes from purposeful goals. motivation and sustained engagement are important to the solving of the problem
- *Being original* – the originality of an outcome which can be at different levels of achievement: individual originality in relation to a person's own previous work; relative originality in relation to a peer group; and historic originality in relation to works which are completely new and unique
- *Judging value* – the evaluative mode of thought which is reciprocal to the generative mode of imaginative activity and provides critical, reflective review from individuals and peers. (Loveless, 2002, p. 10)

Distinctions are to be made between teaching for creativity and creative teaching (Jeffrey, 2000; Prentice, 2000; Joubert, 2001), and a framework which reflects the interaction of people and communities, processes, domains, and fields with technologies instructively drawn. In answering the question, 'How might we teach for creativity with digital technologies?', Loveless (2002) advocates models of access to ICT resources which reflect the following teaching strategies:
Environments which are conducive to creative development are characterised by:

- awareness of the ways in which creativity is related to knowledge across the curriculum;
- opportunities for exploration and play with materials, information and ideas;

- opportunities to take risks and make mistakes in a non-threatening atmosphere;
- opportunities for reflection, resourcefulness and resilience;
- flexibility in time and space for the different stages of creative activity;
- sensitivity to the values of education which underpin individual and local interest, commitment, potential and quality of life;
- teaching strategies which acknowledge 'teaching for creativity' as well as 'teaching creatively'. (p. 4)

Considerable diversity can be found in the ways teachers and learners are using digital technologies to support creativity; ICTs have been used to assist in:

- *Developing ideas*: supporting imaginative conjecture, exploration and representation of ideas;
- *Making connections*: supporting, challenging, informing and developing ideas by making connections with information, people, projects and resources;
- *Creating and making*: engaging in making meanings though fashioning processes of capture, manipulation and transformation of media;
- *Collaboration*: working with others in immediate and dynamic ways to collaborate on outcomes and construct shared knowledge;
- *Communication and evaluation*: publishing and communicating outcomes for evaluation and critique from a range of audiences. (Loveless, 2002, p. 4)

It is important to note that these activities are not always discrete or sequential, and that synchronicity and overlap can exist among the activities. Learners and teachers should ideally draw on a range of experiences through which they can engage, experiment, and become familiar with the benefits which ICTs can make to their creative practices.

2.5.3. Collaborative

> 'The most compelling examples of conversational learning occur when mobile technology is used to provide a shared conversation space. Effective learning occurs when people can converse with each other, by interrogating and sharing their descriptions of the world.'
> (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 27)

In considering the objectives which motivate the use of mobile technologies in education, collaboration is placed at the highest level of use, beyond gains in productivity, flexible physical access, and the capture and integration of data (Gay, Stefanone, Grace-Martin & Hembrooke, 2002). Peer collaboration has been theorised by Vygotsky (1978) and extensively endorsed, *inter alia*, by Newman, Griffin, and Cole (1989), Palincsar (1998), and Spiro, Feitovich, Jacobson, and Coulson (1991), as discussed in section 3. Studies empirically demonstrate that collaborative learning, *i.e.*, having students work in groups towards shared objectives or a 'common purpose' (Resta, 1995), in an environment of communication and exchange with their peers, leads to improved academic results (Johnson & Johnson, 1999; Bannon, 1989; Crook, 1994; Koschmann, 1996).

To benefit from the implementation of constructivist principles in the classroom, theorists Johnson and Johnson (1999) offer the following guidance in their seminal work *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learnings*: 'Have the students work in collaborative learning activities in the construction of new knowledge.' The paramount importance of establishing and maintaining relationships – among the students, with the learning system, and, in reflection, of the students with themselves, is essential to knowledge building (Thomas, 2005).

As noted by Laouris and Eteokleous (2005), learning while interacting with multiple peers has the potential to develop collective cognitive responsibility (Dolan, Holmes, Leahy, Lych, Ward & Amghar, 2005; Bransford, Brown & Cocking, 1999; Churchill, Snowdon & Munro, 2001; Dillenbourg, 1999; Zurita & Nussbaum, 2004; Zurita, Nussbaum & Sharples, 2003). This has been attributed to the fact that collaborative learning offers possibilities for immediate and radical conceptual changes and correction of misconceptions. Engstrøm (2000), amongst others, considers vital the social context and cultural aspects to learning.

In the realm of mobile learning, research undertaken by Zurita and Nussbaum (2004) demonstrates that wireless technologies obviate the weaknesses of coordination, communication, organisation, negotiation, interactivity, and mobility encountered in collaborative learning undertaken without technology. Moreover, Stead (2005) states that in every m-learning project trial assessed, learners engage the most with the learning they can undertake together, either by sharing the wireless devices, or by passing data between them: consequently, learning should be built around this. Evidence exists, according to Becta (2004), the British Educational Communications and Technology Agency, that the employment of wireless technologies can assist in increasing collaborative learning and communication, as well as independent learning among those engaged in education, owing to the mobility and the capacity of the devices. As documented by Barker, Krull, and Mallison (2005), handheld devices allow learner groups to distribute, aggregate, and share information with ease, resulting in more successful collaboration.

Berger, Mohr, Nösekabel, and Schäfer (2003) indicate that although early studies have illustrated the efficiency of collaborative learning, the effect of computer support has been overlooked. Drawing an analogy between support for business processes and those in education, the authors extend three success factors, as stated by König and colleagues (as cited in Berger, Mohr, Nösekabel & Schäfer, 2003): quicker reaction, lower costs, and improved quality. Applied to learning, the indicators of efficiency and effectiveness are that learning materials and course-related information can be distributed and communicated more rapidly, students can contact peer and lecturers anytime and anywhere, and electronic material can be distributed at lower cost and be available at the time and place required for collaborative learning, coordination, and group work (pp. 1-2).

Computer-Supported Collaborative Learning (CSCL) is considered by Gay, Stefanone, Grace-Martin, and Hembrooke (2001), with the system's extension into the mobile domain (MCSCL) explored by Cortez, Nussbaum, Santelices, Rodriguez, Zurita, Correa, and Cautivo (2004). Defined as a computer-based network system that supports group work in a common task, providing a shared interface (Ellis, Gibbs, & Rein, 1991), CSCL systems are primarily designed for group support on projects (Koua & De Diana, 1998; McManus & Aiken, 1996). CSCL systems make use of technology to control and monitor the interaction among participants, distribute information, regulate assignments, rules and roles, and finally, to promote new knowledge acquisition (Cortez, Nussbaum, Santelices, Rodriguez, Zurita, Correa, and Cautivo, 2004). Whereas straight CSCL environments are characterised by students sitting behind PCs placed on desks, mobile-CSCL systems exploiting handheld devices hold the advantage of operating in a more natural interactive environment.

A shift from asynchronous to synchronous communication may result in improved learning performance, as indicated by Frohberg (2004). Pinheiro (1998) introduces the concept of synchronicity to the definition of collaboration thus:

> '[Collaborative learning] is the process of students working in teams to pursue knowledge and learning. In collaborative learning, information, ideas, and problem solving are actively shared among the team. […] Collaboration can also be asynchronous, where students log onto a network at different times and locations leaving their contributions for others to see and discuss.' (pp. 118-119)

The range of synchronous and asynchronous systems to support student learning is represented as a hierarchy from self-study to team learning by Ferscha, Holzmann, and Oppl (2004, p. 68), indicated in Figure 7 below. The sophistication required by team learning may embrace technical support for flexible and extensible frameworks including information and knowledge management systems (representing team memory), interaction systems (for meeting support), mobility systems, organisational innovation systems, and a novel 'awareness system' proposed by the authors (Ferscha, Holzmann & Oppl, 2004, p. 68). Based on the work of Dourish and Bellotti (1992), the awareness system seeks to 'communicate work context, agenda and workspace information just-in-time to the user interfaces of relevant team members and granting anytime access to team memory' (Ferscha, 2000, cited in Ferscha, Holzmann & Oppl, 2004, p. 68).

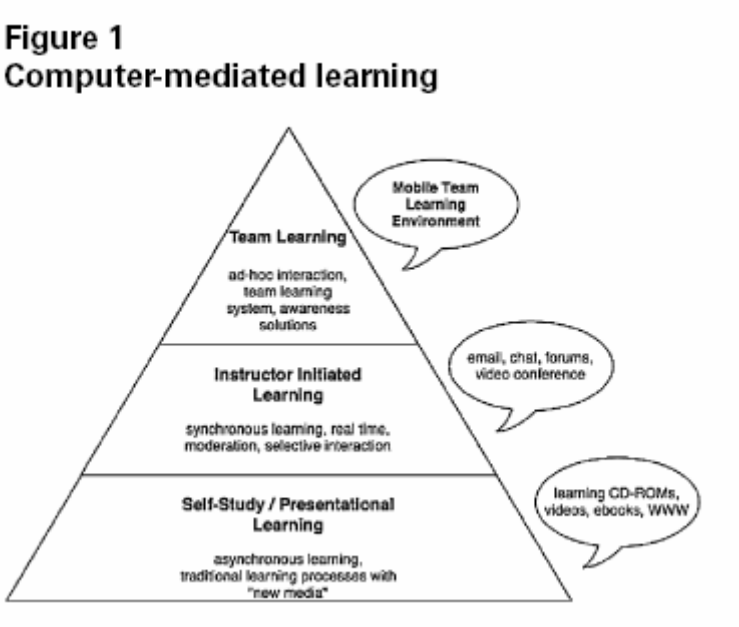

Figure 7: Hierarchy from self-study to team learning (Ferscha, Holzmann, & Oppl, 2004, p. 68, Figure 1)

The multifarious forms which either asynchronous or synchronous collaboration may take are enumerated by O'Nuallian and Brennan (2004), to include features such as:

1. Talking in groups: as in a classroom discussion or telephone conference;
2. On a one-to-one basis: peer-to-peer in the classroom or on the phone;
3. E-mail: this can exist through the use of standard clients like Outlook or Eudora or can be built into the delivery application;
4. Forums: online question-and-answer sessions/forums with classes (where tutors moderate);
5. Texting: on SMS-enabled devices;
6. Voice-enabled applications;
7. Online folders for files: these include shared folders on the network or on individual personal computers;
8. Videoconferencing; and
9. Mentoring: this occurs when a subject-matter expert engages with the class or individual students in the resolution of issues that the student may have encountered. (p. 150)

Depending on the device, the student's learning style, and connectivity available, advantages associated with collaborative learning are notionally manifold. Acknowledging the need for specific empirical studies, Berger, Mohr, Nösekabel, and Schäfer (2003) propound that 'Collaborative learning combined with the advantages of mobility and electronic content will very likely improve the acquisition of knowledge, lower costs and advance the social skills of the students' (p. 2). Several advantages to mobile learning have been advanced by Nikana (2000), to include:

1. *Increased understanding of the material/curriculum content*: through the different collaborative methods and initial delivery approaches, the student is provided with an increased understanding and depth of knowledge regarding the material/curriculum content;
2. *Increased motivation through discussion*: through group discussion and dialogue, the user is motivated to learn more;
3. *Quick and effective feedback*: discussion and the repetition of ideas and material (through different presentation formats) reinforces learning, thereby increasing memory retention;

4. *Cost effectiveness*: by this, we mean that one should not always be 'eager' to develop new interfaces, but instead should use what is available and effective;
5. *A good assessment tool* for the student;
6. *A good means for the tutor to identify the level of the student's knowledge*;
7. *Reinforcing*: it acts as a means of reinforcing existing material;
8. *Alternative views*: it allows for different perspectives to be examined and tested for effectiveness, through discussion;
9. *Bonding*: increased tutor and student bonding, to help shy and less enabled students to obtain the tutor's attention without embarrassing themselves; and
10. *Student retention*: increased student retention as a result of increased student motivation and understanding.

Specific mobile technologies supporting collaborative learning are introduced by Berger, Mohr, Nösekabel, and Schäfer (2003), relating to a personal digital assistant (PDA) supporting the wireless application protocol (WAP); Cochrane (2005), who proposes a primer for utilising wireless palm devices to facilitate the collaborative learning environment; Ferscha, Holzmann, and Oppl (2004), who propose an extensible awareness system; in addition to the review undertaken by Savill-Smith and Kent (2003) concerning the use of palmtop computers for learning. A platform, ConcertStudeo, which provides tools for interactions through the use of PDAs in combination with an electronic blackboard, is proposed by Dawabi, Wessner, and Neuhold (2003); tablet PCs are considered by Corlett and Sharples (2004); whilst a conceptual model termed MoDCA (Mobile Device Collaboration and Assessment) is proposed by O'Nuallian and Brennan (2004). A specific implementation of collaborative learning in the mobile environment has been considered by Frohberg (2004); and Burke, Colter, Little, and Riehl (2005) present statistics from the University of Tennessee's Innovative Technology Center concerning mobile learning implementations.

In Berger, Mohr, Nösekabel, and Schäfer (2003), a collaboration tool has been integrated into the e-learning and m-learning environments, allowing users to create workgroups, both public and private, which include functions for messaging, discussion, and administration, and for use of a blackboard tool. Participants are invited to contribute via SMS or email, and are able to exchange files via a Web page. Collaborative features allow students to engage in discussions, to exchange ideas, and to share documents which are version controlled.

New Zealand academic Thomas Cochrane (2005) foresees the potential for establishing the use of Palm PDAs as core ICTs within the tertiary education environment. When integrated into a campus-wide wireless network, PDAs employing open-source freeware, shareware, or commercial software may facilitate the use of electronic tools to enhance tutor-student and student-student communication, collaboration, reflection, and critique. Within the ubiquitous computing environment, student productivity should be enhanced, Cochrane (2005) asserts.

Ferscha, Holzmann, and Oppl (2004) emphasise the importance of team awareness to personalised learning environments. Such a system seeks to offer up-to-the-moment information about the location, state, and activities of learning teams, thereby building awareness of the context of student learning. Asynchronous and synchronous communication tools are provided within a sophisticated framework to support team-based activities.

Savill-Smith and Kent (2003) consider a range of materials regarding palmtop computers in the mobile learning environment. They cite programs such as the Microsoft Anywhere Anytime Learning scheme, where the use of laptop computers has led to increased collaboration both inside and outside of school, in the ability to document activities, and promotion of improved thinking skills and problem-solving in learners. Here, teachers are considered more as facilitators than traditional lecturers.

As discussed in section 4.1 on tablet PCs, Cortlett and Sharples (2004) document a trial examining informal collaboration in higher education using tablet PCs. Findings indicate that this mobile device facilitates the use of several collaborative activities for team meetings; namely, instant minute-taking and sharing, making an audio recording of the meeting (of particular value to those working in a second language), using a shared whiteboard, offering show-and-tell demonstrations of project deliverables, transferring files, and immediately following up requests for emails and project-related information.

Dawabi, Wessner, and Neuhold (2003) present an approach to the integration of mobile devices, such as PDAs, in face-to-face learning scenarios which combines the benefits of both traditional and mobile contexts. ConcertStudeo, a platform implementing their approach, provides tools for interactions, such as brainstorming, quizzes, voting, and the use of an electronic blackboard wirelessly connected to a PDAs.

O'Nuallian and Brennan (2004) consider how to assess students working in a collaborative mobile environment on an individual basis. The previous inability of systems to deliver personalised content to PDAs, mobile phones, and laptops has prompted the development of a conceptual model termed MoDCA, Mobile Device Collaboration and Assessment. This model defines the manner in which learning objects should be presented and how pedagogical principles should be adapted to different wireless platforms 'in such a manner as to promote effective learning and assessment for individuals with diverse learning needs which are continuously changing and adapting' (p. 149).

A specific implementation of collaborative learning in the mobile environment has been considered by Frohberg (2004), who indicates that the establishment of a community network may last longer than the specific course in which the students were enroled (in this case, the MBA). Chronicling both synchronous and asynchronous interactions, Frohberg (2004) notes that the more opportunities that exist for informal exchanges between students, the better.

In a presentation to an EDUCAUSE ELI meeting concerning strategies to harness collaborative learning with nomadic communities, Burke, Colter, Little, and Riehl (2005) demonstrate the distribution and use of wireless technologies at the University of Tennessee, illustrating types of hardware and software used, and specific support provided. They gauge student and staff experience and comfort level in the use of the mobile technologies, and how working in groups has been received.

It is manifest that the possibilities for collaborative learning are increasing, indicating that learning is demonstrably enhanced when such communication and cooperation towards shared objectives are involved. It must be emphasised, however, that for any implementation, there is a specific need to consider the pedagogical aspects of learning, the psychology of collaboration, the heterogeneous nature of mobile devices (particularly, from the user interface perspective), and the importance of effective assessment which considers the individual as well as the team (O'Nuallian & Brennan, 2004). Importantly, the

design of technical systems must be careful to preserve the traditional advantages of face-to-face teaching and learning scenarios (Dawabi, Wessner & Neuhold, 2003).

2.5.4. Communicative

> 'Society not only continues to exist *by* transmission, *by* communication, but it may fairly be said to exist *in* transmission, *in* communication. There is more than a verbal tie between the words common, community, and communication. [People] live in a community by virtue of the things they have in common; and communication is the way in which they come to possess things in common.' (Dewey, 1916, cited in Nyíri, 2002, p. 1)

Nyíri (2002, p. 4) defines m-learning as learning as it arises in the course of person-to-person mobile communication. Espousing a philosophy of the newly emerging discipline, Nyíri (2002) sees that communication is an anthropological necessity, which is further facilitated by the integration of mobile devices into learning.

The facilitation of improved communication and interaction between staff and students in the university environment via mobile technologies has been specifically considered by Divitini, Haugalokken, and Norevik (2002), Beale and Jones (2004), and McGovern and Gray (2005), with Field (2005) considering the blended learning environment. The delivery of appropriate administrative support as well as timely course content is key to engagement in the increasingly competitive communication environment, where 'information overload' or a high cognitive load (Frohberg, 2004) is of real concern.

Support for timely communication and for independent learning in the student body is discussed by Divitini, Haugalokken, and Norevik (2002). With the observation that students often complain that 'despite all the information channels they have available, they are still not able to get the information that they need when they need it' (p. 1), the authors seek to explore the 'potentialities' of mobile technologies for coordination and communication. The research, presented at IEEE WMTE 2002, has the stated aim to investigate the challenges of using mobile technologies for:

- Providing students and teachers with the information they need as soon as it is available, independently by where they are;
- Providing teachers a new communication channel with students;
- Fostering cooperation among students and among students and teachers. (Divitini, Haugalokken & Norevik, 2002, p. 1)

Presenting the preliminary results from a survey distributed to investigate actual usage of mobile technologies by students, and their interest in adopting them in the educational context, the authors reveal that students already used mobile devices to communicate with their peers. In particular, SMS messages were used to coordinate with fellow students. Students also displayed interest in receiving SMS messages from the university to convey information. Importantly, students seek to keep control of what information they receive and when. The university must then decide on whether to adopt a push or pull SMS strategy, and determine the exact content to be disseminated. The facility for group sending of messages must also be enabled. In sum, 'the preliminary results obtained by this research show that there is space and interest for mobile applications for improving communication and cooperation in the educational context' (Divitini, Haugalokken & Norevik, 2002, p. 3).

Beale and Jones (2004) describe the design and implementation of an intelligent messaging system to provide a communication channel for students and staff when office-based interactions fail. The authors employ the concept of 'situated interaction' (Streitz, Röcker, Prante, Stenzel & van Alphen, 2003), indicating the increased interaction brought about by mobile and other technologies in the learning domain. Seeking to bridge the gap they perceive currently exists between learner and instructor, Beale and Jones (2004) implement the intelligent messaging system to allow an increased degree of mobility and remote accessibility necessary for modern learning situations.

The requirements for communication to the student and lecturing body in terms of university infrastructure have been assessed by McGovern and Gray (2005) at the Royal Melbourne Institute of Technology (RMIT). In surveying 1062 students in relation to their needs in the electronic domain, 249 responses have related to communication. The majority of responses (71) related to the passive receiving of announcements, notices, information and messages through SMS push technology. As represented in Figure 8 (McGovern & Gray, 2005, p. 392), the remainder indicated more two way activity, communicating with lecturers (58), participating in online discussions (28), communicating with other class members (23), sharing ideas and information with other class members (20), facilitation of group work (13), to communicate better in general (9), to communicate more flexibly (6), to connect with their course and with RMIT better (6), getting feedback on ideas from staff and other students (5), to more easily ask a difficult question (4), to communicate about assignments (3), and communicating with students in other courses or programs (3).

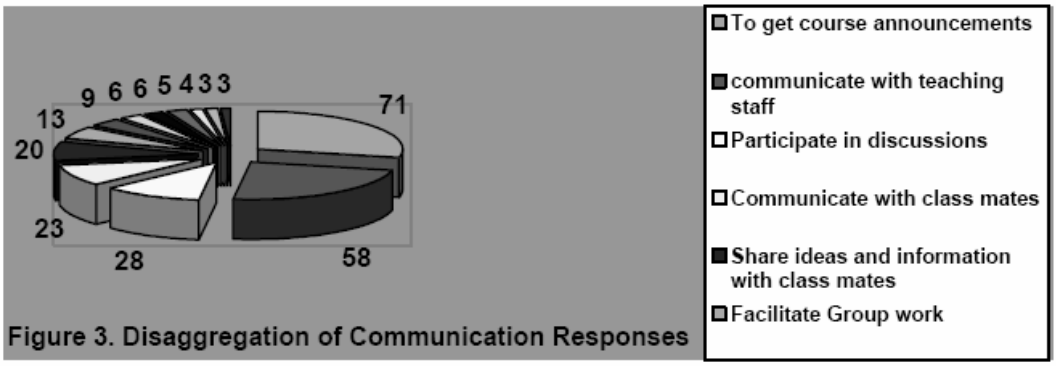

Figure 3

Figure 8: Disaggregation of Communication Responses (McGovern & Gray, 2005, p. 392)

In exploring favourable conditions for effective and efficient blended learning, Field (2005) highlights the importance of engaging in explicit communication and collaboration with the study body. The extensive use of online notices and emails which attempt to replicate productive elements of face-to-face communication, such as using engaging and enthusiastic writing styles (Bender, 2003, p. 52, citing TEDI, 2000), are critical to motivate students (Wlodowski, 1999, pp. 9-10). Creating a sense of connection and community is key to achieving positive learning outcomes, and should be reinforced when engaged in face-to-face classroom communication.

2.6. Distributed Networking, Diverse Participants

> 'Situation-dependent knowledge, the knowledge at which m-learning aims, by its nature transcends disciplines; its organizing principles arise from practical tasks; its contents are multisensorial; its elements are linked to each other not just by text, but also by diagrams, pictures, and maps.' (Nyíri, 2002, p.4)

Nyíri's (2002) philosophy of m-learning explicates that questions arising in the course of mobile communication seek location-specific and situation-specific answers, which will create a context in which the learning may take place: this is where information becomes knowledge. Nyíri (2002) emphasises that m-learning has to be focussed on providing answers to practical problems, rather than being based on pre-existing disciplinary matrices. Moreover, materials will have to fit the conditions of person-to-person communication. As 'verbal and pictorial information circulates, a knowledge community is thereby formed' (Nyíri, 2002, p. 4). The establishment of field-based curricula is an appropriate beginning to the task.

Several projects are presented in which distributed networking with diverse participants is discussed. Based on apposite learning theories and pedagogies including collaborative and cooperative learning, situated learning (Lave & Wenger, 1991), peer-assisted learning (Topping & Ehly, 1998) and vicarious learning (Lee, McKendree, Stenning, Cox, Dineen & Mayes, 1999), the project findings indicate that student engagement and successful learning outcomes increase in an authentic environment. In sum, new dimensions to learning and education are realised with the use of mobile devices. Technically, however, context awareness is not easy to achieve, as will be noted in the consideration of Wang (2004).

Systems supporting synchronous and asynchronous interaction for individuals and teams have been introduced by Ferscha, Holzmann, and Oppl (2004). The researchers have developed and implemented an extensible, dynamic architecture (Beer, Hill, Huang & Sixsmith, 2003), which derives several dimensions of context from individual users to create team awareness information. Team members are presented with this information on their members' activities and locations, giving them the ability to interact with accurate guidance and social awareness.

Silander, Sutinen, and Tarhio (2004) present an application and framework for mobile collaborative concept mapping ('MoCoCoMa') using the SMS facility of mobile phones. Providing the opportunity to conduct simultaneous activity in a classroom and an authentic environment, their system makes conscious use of low-cost, already available technology (namely, widely diffused mobile phones), which does not require any special wireless network, such as a WLAN, or bespoke telecommunications infrastructure. The authors intend that mobile technology is used 'not just as a mediator (of learning activity/collaboration) but as a trigger and platform that includes guidance and support for learning methods and the learning process' (Silander, Sutinen & Tarhio, 2004, p. 1). In their study, students equipped with mobile phones are sent into the forest to record their observations, represented as text-based concept maps, which are structured as SMS messages and sent to students in the classroom. The authors acknowledge that PDAs and other computer-like handheld devices would have the advantage of a graphical interface which would facilitate physically distributed cognition (Chan & Sharples, 2002); however, the lack of visual presentation may require the student to use more cognitive effort to create his/her own mental data structures and thus to collaborate with other students.

When assessed, the Silander, Sutinen, and Tarhio (2004) study indicated that students respond favourably to using SMS as a tool of learning and interaction. No serious technical or pragmatic problems were encountered, or those potentially relating to different individual learning styles or cultures. The system also retains the ability to be up-scaled, as it is based solely on SMS architecture, which is pervasive. In a separate paper presented by Burke, Colter, Little, and Riehl (2005) for EDUCAUSE, the possibilities for group sending of SMS have been considered as critical for student collaboration.

Roles adopted by participants in remote field trips are discussed by Hine, Rentoul, and Specht (2003), together with the dynamics of collaboration in the mobile environment. The authors introduce the Remote Accessible Field Trip (RAFT) project, emphasising that the background to the investigation has been the endeavour to embed the remote learning experience in the curriculum. As illustrated in Figure 8: Learning theory examples in RAFT (p. 70), the researchers contextualise their experiment against peer-assisted (Topping & Ehly, 1998), collaborative, cooperative (Johnson & Johnson, 1994), situated (Lave & Wenger, 1991), and vicarious (Lee, McKendree, Stenning, Cox, Dineen & Mayes, 1999) learning pedagogical principles.

Table 1 Learning theory examples in RAFT

Learning theory	RAFT examples
Situated learning	Field trips present many real-life practical problems to be solved and demands from several directions. Examples: visiting and interviewing a professional – an artist in their studio, a journalist at work, a scientist in the laboratory.
Collaborative learning	Working with peers in the field and in the classroom; distributed working with other students in different parts of the world on topics of mutual interest.
Cooperative learning	Group tasks, eg on pollution in river. Within the group there are roles, eg researcher, communicator, measurer, collator and developer. Each contributes to achieve the joint result – a 'jigsaw' process.
Peer-assisted learning (PAL)	In the field, a visually impaired student may be assigned a student to be his/her visual helper – the two work together gathering information for their group.
Vicarious learning	A student takes the role of process observer in a group investigating the Roman Army. The student 'learns' different techniques from observing other groups' approaches to their tasks. This is 'meta-learning'.

Figure 9: Learning Theory Examples in RAFT (Hine, Rentoul, & Specht, 2003, p. 70)

With the intention to ensure that all participants are fully engaged in the field trip experience, each student adopts a particular role in a team which has been designated a specific task, whether that be based in the classroom or in the field. Initial examples of roles to be adopted in the classroom context include coordinator, communicator, researcher, and archivist, and in the field, communicator, scout, data gatherer, and annotator. In insisting on the allocation of such roles, the teachers ensure that all students work towards a common goal, and that each student's contribution is valued.

Collaborative note taking is addressed by Singh, Denoue, and Das (2004), who introduce a project which enables students in a class on wireless mobile computing to take notes on PDAs and share them with their study group in real-time. An instructor's slides are sent to all PDAs as they are displayed, allowing students to annotate what they see, with their notes sent automatically to all members of their group. These notes can then form the basis of a student's notes on the lecture. Technically, the collaborative note taking system operates in a client-server mode, having three main components: the user interface for creating notes; a real-time slide extractor module; and the note server. Findings indicate that circulating what others are writing makes note taking livelier and increases awareness; in addition, users are able to reuse and adapt terminology and concepts of others which is a valuable time-saving feature.

> 'Not only must we design for multiple users with potentially different roles, we also have to consider that the activities will take place in open technical environments with various software and hardware components, which are not under our control.' (Milrad, Hoppe, Gottdenker & Jansen, 2004, p. 1)

Milrad, Hoppe, Gottdenker, and Jansen (2004) explore the use of mobile devices to support hands-on scientific experimentation and learning. Key to this research has been the creation of novel applications to support interoperability between diverse and distributed mobile devices, to provide the 'glue' to adhere different learning situations. Deriving impetus from the work of Soloway, Grant, Tinker, Roschelle, Mills, Resnick, Berg, and Eisenberg (1999), the authors note that handheld computing devices allow for scientific and technical exploratory activities which are not bound to a specific location, and do not lose the potential for students to take electronic notes and retrieve information of various types. When combined with wireless connectivity, activities such as field trips can be continuously monitored and coordinated across time and space. Emphasis is placed on interoperability, for its ability to provide functions including media integration and flexible, scalable re-use of learning objects.

The technical requirements for context awareness and adaptation in mobile learning are discussed by Wang (2004). As described, context-aware mobile learning (CAML) system examines sensed learning contexts and reacts to changes in the learning environment (p. 2). CAML derives data from mobile learners who carry portable devices with augmented hardware sensors, such as GPS receivers, wireless LAN connections, and cameras, as well as software sensors such as network congestion managers, Web log and behavioural analysers, to detect location, activity, network connectivity, learner state, and other metrics. Acknowledging that the successful learning experience is founded on highly context-sensitive activities, 'context' is conceptualised in six dimensions to form a context space, as enumerated below:

1. *Identity Dimension*: The identity of the learner is essential to CAML, and must be unique to the namespace; usually established at logon, or through smartcards or fingerprint readers;
2. *Spatio-temporal Dimension*: A user's time and location are useful to a wide range of applications;
3. *Facility Dimension*: The type of mobile device being employed, and the status and standards of wireless and wired connectivity are required to provide support for intelligent interfaces;
4. *Activity Dimension*: The status of specific assignments, participation in discussions and group collaborations are all able to be assessed;
5. *Learner Dimension*: Knowledge of the specific traits and preferences of the learner is crucial to the success of the learning experience;

6. *Community Dimension*: Complex social contexts are indicated from status and interactions among members of the community; various learning activities can be interlaced across time, place, school, home, and expertise, for example.

Wang (2004) insists that best-practice design principles for context-aware mobile learning will take considerable time to develop, but are crucial to the endeavour. In future research, the author proposes to create several prototypes, in particular a university learning system coupled with a wireless learning pet. It is intended that these applications will explore the use of a variety of different context elements and evaluate which are effective for specific applications. Wang's (2004) framework has been extended to a seventh dimension, 'team awareness', by Ferscha, Holzmann, and Oppl (2004), to broaden the notion of user from the individual to the group.

The technical demands of an application session teleportation (AST) framework to allow seamless access to applications from multiple devices moving between personal area networks (PANs) are considered by Gardner, Chua, and Shahi (2004), in the context of ubiquitous computing. With implications for users who are collaborating through shared Web sessions from different devices, the project engages in several experiments concerning session adaptation, heterogeneous device collaboration and design metrics for co-browsing. Current collaboration from different devices may well mean that different users have completely different views of the same shared information. The primary objective of this project therefore becomes to adapt relevant information based on the perceived 'utility' of Web objects and the capabilities of mobile devices being employed.

2.7. Game Playing

> 'Computer games engage. They are seductive, deploying rich visual and spatial aesthetics that draw players into fantasy worlds that seem very real on their own terms, exciting awe and pleasure.' (Poole, 2000)

Current thinking in educational psychology emphasises the importance of play in the learning process (Rodríguez, Nussbaum, Zurita, Rosas & Lagos, 2001). Providing the opportunity to rehearse novel activities and to reflect on ideas without the consequences of operating in the 'real world', game playing is a primary activity for young learners, and increasingly for older students. Introduced over the last two decades with the aim of 'tutoring, amusing, helping to explore new skills, promoting self-esteem, practising skills, or seeking to change attitudes (Dempsey, Rassmussen & Lucassen, 1994, p. 1), computer games are gaining greater attention as tools to encourage thinking, reflecting, and creativity (Becta, 2001). In the field of mobile learning, the integration of games into the curriculum is receiving increasing exposure (Thomas, Schott & Kambouri, 2003; Jones, Larson, Weaver & Caliph, 2005; refs).

Authors Alice Mitchell, Carol Savill-Smith, and Jill Attewell have contributed significantly to the discussion on the use of mobile technologies in relation to gaming through their association with the m-learning project (see section 5.6.2). In their publications, which should be read in full to gain insight into the area, the following research questions have been pursued:

- What is the impact of the use of computer and video games on young people?
- Why use computer games for learning?
- How have computer games been used for learning?
- What are young people's experiences and preferences in using computer games for learning and for leisure?
- What are the recommendations for the planning and design of educational computer games (or 'edugames')? (Mitchell & Savill-Smith, 2004, p. 3)

In reviewing over 200 publications for the m-learning project, Mitchell and Savill-Smith (2004) reveal the manifold and multifarious claims for and against the usefulness of computer games in encouraging learning. The rationale for their introduction is often cited as stimulating enjoyment, motivation and engagement of users, aiding recall and information retrieval, and encouraging the development of important social and cognitive skills. Reasons regularly cited against the introduction of games are that they exacerbate negative psycho-social tendencies, such as social isolation and even violence or aggression, that their use is addictive, and that further health implications can accrue (p. 1).

In seeking to analyse the use of computer games to encouraging learning, Mitchell and Popat (2003, p. 105) collate the following sources in a section, which owing to its richness, is replicated in full:

> A growing number of researchers and theorists (Dempsey *et al*. 1994; Doolittle 1995; Griffiths 1996; de Lisi and Cammarano 1996; Emes 1997; Mumtaz 2001; de Lisi and Wolford 2002; Kirriemur 2002; Ko 2002; Pillay 2003) ascribe significant benefits to use of computer games in educational settings. They have been found to:
>
> - act as ice-breakers and rapport-builders (Spence 1988; Gardner 1991; Lynch 1981 and 1983; Phillips 1991; all cited by Griffiths 1996);

- stimulate curiosity, discovery learning and perseverance (Ehman and Glenn 1991 cited by Berson 1996; Ko 2002; Kirriemur 2002);
- enable risk-free experimentation (Berson 1996);
- promote spatial learning and cognitive processing (McClurg and Chaille 1987);
- provide motivation via immediate feedback (Roubidoux *et al.* 2002);
- enhance self-esteem and confidence (Ritchie and Dodge 1992);
- support cognitive apprenticeship (Greenfield *et al*. 1996) especially where users have control over the tools (Small and Samijo 1997).

Prensky (2001) emphasises the importance of a user-relevant context and recommends selective use of games styles geared to both content and learning activities. Other authors concur with this view including Brownfield and Vik 1983; Randel *et al*. 1992; Griffiths 1996). Studies conducted by the British Educational Communications and Technology Agency (Becta) offer the following ideas for incorporating computer games into learning environments (Kirriemur 2002):

- multi-user online games used in class and linked to formal homework or an informal fun activity could enable students to access and exchange data with classmates or students elsewhere and then e-mail their work back to the teacher;
- multi-user online games used with networked library services could encourage collaborative research activity (although research was advocated to test whether this was feasible).

Prensky (2001) suggests that computer games may incorporate as many as 36 central learning principles. Examining the engagement of users, Prensky (2001, pp. 106-7) tabulates the characteristics of computer games and how they contribute to players' enjoyment, as shown in Figure 10:

Table 2 Engaging characteristics of computer games

Characteristic of the computer game	How they contribute to players' engagement
Fun	enjoyment and pleasure
Play	intense and passionate involvement
Rules	structure
Goals	motivation
Interaction	doing (ie the activity)
Outcomes and feedback	learning
Adaptive	flow
Winning	ego gratification
Conflict/competition/ challenge and opposition	adrenaline
Problem-solving	sparks creativity
Interaction	social groups
Representation and a story	emotion

Adapted from Prensky 2001, pages 106–7

Figure 10: Engaging Characteristics of Computer Games (Prensky, 2001, pp. 106-7, cited)

Ideas to underpin future research into educational applications of computer games are suggested by Mitchell and Savill-Smith (2004, p. 61), with limitations

of current published research being identified by Mitchell and Popat (2003, p. 106). With examples derived from Subrahmanyam, Greenfield, Kraut, and Gross (2001, pp. 26-7), Mitchell and Savill-Smith (2004, p. 61) offer the following areas for investigation:

- The 'cognitive and social effects of the newer generation of video games and other software, especially the multi-user games now available on the Internet … [exploring] more fully the relation between violent games and children's aggression, particularly whether repeated game playing can desensitise children to the impact of violent behavior' (Subrahmanyam, Greenfield, Kraut & Gross 2001, p. 26).
- The long-term cumulative impact of interactive games on cognition and academic achievement (Subrahmanyam, Greenfield, Kraut & Gross, 2001, p. 26). This concern was also expressed by Griffiths and Davies (2002).
- 'The increasing dominance of simulated worlds (vs real-world experiences) in children's daily experiences and their impact on children's and adolescents' developing identities and sense of reality are topics meriting serious attention' (Subrahmanyam, Greenfield, Kraut & Gross, 2001, pp. 26–27).

Current mobile learning projects exploring computer games are varied, with Thomas, Scott, and Kambouri (2003) setting usability guidelines for educational games in the mobile learning context. Extension into the realm of animated pedagogical agents may be warranted, as examined by Jones, Larson, Weaver, and Caliph (2005). A previous literature review in the area of animated agents completed by this report's author should be considered here.

3.0. PEDAGOGICAL UNDERPINNINGS

3.1. Best Practice Blend

> 'The question is no longer whether m-learning works for hard-to-reach learners, but rather how best to fit it into your blend!' (Stead, 2005, p. 1)

Adherence to best practice pedagogical principles should lie at the heart of any m-learning project. Supporting the examination of both face-to-face and online contexts, Field (2005) propounds that 'the question of what we do with our lecture time needs ongoing critical reflection, if tertiary educators are to make effective and efficient learning possible' (p. 209). Lecturers should manifest a commitment to active student learning as the key facilitator of deep learning (Laurillard, 2002, p. 13, with reference to Vygotsky (1962, 1978), Piaget (1929, 1972), Bruner (1983, 1986), and Papert, (1980, 1994)). Pertinent pedagogical principles, as considered by current research, are presented in this section in support of this initiative.

The achievement of best practice for blended teaching and learning requires the commitment to using technology for more than 'bolt-on information provision; rather for engagement and connection, and to create a scholarly community of practice in which students can participate flexibly. Online methods for learning and teaching must therefore be "viewed as a new context for learning, not just as a tool" (Salmon, 2000, p. 17).' (Field, 2005, p. 211)

Blended learning, characterised by the integration of electronic and face-to-face educational environments, is considered by Thorne (2003) to represent a universally applicable learning style, functioning as 'a logical and natural evolution of our learning agenda' (p. 16). Blended learning seeks to create educational experiences that 'provide the right learning at the right time and in the right place for each and every individual, not just at work, but in schools, universities and even at home' (p. 18), and as such, will be a significant contribution to pedagogical principles in the 21st century.

In describing the new 'digital pedagogy', Lloyd and Irvine (2005) advocate that lecturers need to balance technical and human demands so as to achieve mobile learning goals, and to maintain fidelity with their existing beliefs about teaching and learning. Acknowledging that the issue of developing and using mediated learning environments is a complex, challenging, and ongoing process, Lloyd and Irvine (2005) state there is a need for: 'A robust environment in which reliable and immediate technical support is available and an industrial environment which is considerate of altered work practices and conditions' (p. 378). These are fundamental factors to the success of individuals and institutions adopting and developing effective mediated learning environments.

In summary, pertinent lessons 'e-learned' need to be taken into consideration, as outlined by Wagner (2005):

- Learning is a deeply personal act that is facilitated when the learning experiences are relevant, reliable, and engaging;
- Different kinds of learning demand appropriate strategies, tools, and resources;
- Technology in and of itself may not guarantee better learning;
- The better the experience and the more intentional the results, the greater is the likelihood that learning will occur. (p. 48)

A summary of activity-based pedagogies is presented by Naismith, Lonsdale, Vavoula, and Sharples (2004) in the NESTA Futurelab report on mobile technologies and learning, as demonstrated in Figure 11.

Theme	Key Theorists	Activities
Behaviourist learning	Skinner, Pavlov	▪ Drill and feedback ▪ Classroom response systems
Constructivist learning	Piaget, Bruner, Papert	▪ Participatory simulations
Situated learning	Lave, Brown	▪ Problem and case-based learning ▪ Context awareness
Collaborative learning	Vygotsky	▪ Mobile computer-supported collaborative learning (MCSCL)
Informal and lifelong learning	Eraut	▪ Supported intentional and accidental learning episodes
Learning and teaching support	n/a	▪ Personal organisation ▪ Support for administrative duties (e.g. attendance)

Figure 11: An activity-based categorisation of mobile technologies and learning (NESTA Futurelab Report 11, p. 18)

3.2. Social Construction of Knowledge

> 'Learning is a social process that occurs through interpersonal interaction within a cooperative context. Individuals, working together, construct shared understandings and knowledge.' (Johnson, Johnson & Smith, 1991, p. 11)

When considering the dynamics of mobile learning, several pedagogical principles and theories are expounded and espoused: these include the notions of Social Constructivism, Situated Learning, Situated Cognition Theory, Contextual Life-long Learning, Conversation Theory, Activity Theory, and Relationality. In assessing the sources emphasising the centrality of context and collaborative activity, it is clear that the social construction of knowledge is of primary significance to the discipline of mobile learning.

It may be said that the key papers considering the centrality of social interaction have been contributed by Sharples (2000), and further in Sharples, Corlett, and Westmancott (2002). These papers propose a general theory of personal learning mediated by technology, founded on social constructivist theories (for example, Brown & Campione, 1996) and on Conversation Theory (Pask, 1976). In addition, these theories are supplemented by further detailed analysis of the cognitive, social, and cultural aspects of learning, such as summarised by Jarvis, Holdford, and Griffin (1998).

The primary rationale of these papers is that personal learning commences with a learner in a social, cultural, and technological environment: 'learning is a constructive process of acting within an environment and reflecting upon it' (Sharples, 2000, p. 4). Action encompasses the ability to solve problems, engage in dialogues of enquiry, and to acquire new knowledge. Reflection indicates that the learner will engage in abstracting from a situated activity, having the ability

to integrate current experience with previous knowledge and to construct new interpretations. Conversation, at the levels of action and reflection, is central to this activity, and occurs between learner and teacher in a dialogic fashion. This will be considered in greater detail in section 3.6. To pursue the iteration of Cs for this learning generation (Trendwatching.com, 2005), construction, conversation, and control have primacy (Sharples, Corlett & Westmancott, 2002).

In addition, Activity Theory is proposed as a pedagogical underpinning to mobile learning, where technology is perceived as a tool to mediate human activity. As is demonstrated in section 5.3 on collaboration, and further endorsed by Crawford (2004), there is a perceived need to rebalance human activity (specifically, the learning experience) more positively towards the collective – focussing on cooperation, communication, co-learning, co-inventing, and co-evolution (Crawford, 2004).

The aim of systems designed with these pedagogies in mind is to be human-centred, based on a sound understanding of how people 'think, learn, perceive, work, communicate and interact' (Sharples, Corlett & Westmancott, 2002, p. 222). In utilising mobile learning environments, learners should be enabled to integrate learning episodes across time, to support their growth and transformation of knowledge (Sharples, Corlett & Westmancott, 2002, p. 221).

3.3. Social Constructivism

Educational researchers (Brown, Collins & Duguid, 1989; Resnick, 1987; Soloway, Grant, Tinker, Roschelle, Mills, Resnick, Berg & Eisenberg, 1999) argue that students learn best when given the opportunity to learn skills and theories in the context in which they are used, then construct their interpretations of a subject and communicate those understandings to others (Gay, Stefanone, Grace-Martin & Hembrooke, 2001).

Social constructivism is an educational theory that proposes that knowledge is constructed by individuals based upon their own prior experiences, in a particular context (Honebein, Duffy & Fishman, 1993).

To benefit from the implementation of collaborative constructivist principles in the classroom, theorists Johnson and Johnson (1999) offer the following guidance in their seminal work *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learnings*:

1. Start from the student's current cognitive development and knowledge level;
2. Make it possible for the students, on their own account, to construct and acquire new knowledge through significant learning experiences based on the modification of their prior knowledge;
3. Establish relationships between the construction of the new knowledge and the students' already-existing knowledge outlines;
4. Have the students work in collaborative learning activities in the construction of new knowledge.

Misfud (2003), following Soloway, Norris, Blumenfeld, Fishman and Marx (2001), bases her paper on the premise that flexible access to handheld technology will provide the tools to help learners construct knowledge throughout their daily activities, thereby making this technology an integral part of daily learning. Moreover, learning will increasingly occur in contexts outside the classroom (Lave & Wenger, 1991; Resnick, 1987), where the importance of community contexts becomes paramount (Sharples, 2000).

3.4. Situated Learning

According to situated learning, as espoused by Lave and Wenger (2001), knowledge and skills are created in contexts which reflect how knowledge is obtained and applied in everyday situations. Situated learning occurs whenever there is a 'break in the flow of routine daily performance and the learner reflects on the current situation, resolves to address a problem, to share an idea, or to gain an understanding' (Sharples, 2000, p. 2). This is typified by occurring in a serendipitous fashion, as when problem-solving leads to unconventional ways to answer the question, or when conversation sparks a reflective train of thought. As observed by Colley and Stead (2003), educational research into situated learning points out the importance of giving learning a context.

As perceived by Holzinger, Nischelwitzer, and Meisenberger (2005), situated learning is a combination of cognitivistic and constructivistic approaches, in which the learning situation plays a central role during the knowledge construction process (p. 2). 'Situation' encompasses aspects of the physical, social, and cultural environment, including communication with peers during the learning process.

Hull (1993) endorses such a view (as cited in Ferscha, Holzmann, and Oppl, 2004):

> According to contextual learning theory, learning occurs only when learners process new information of knowledge in such a way that it makes sense to them in their frame of reference (their own inner world of memory, experience and response). This approach to learning and teaching assumes that the mind naturally seeks meaning in context – that is, in the environment where the person is located – and that it does so through searching for relationships that make sense and appear useful.

3.5. Situated Cognition Theory

As defined by Kirschner and Whitson (1997), and adopted by Colley and Stead (2003), situated cognition theory conceives of learning as a socio-cultural phenomenon rather than the action of an individual requiring general information from a decontextualised body of knowledge. Whilst the use of a mobile phone or palmtop computer may seem to be an isolated and isolating, individualistic activity, research clearly demonstrates that it is the communication which the device facilitates which is a primary boon to its adoption (Colley & Stead, 2003). Prensky (2001) therefore advocates the development of games for mobile devices which are usable by groups as well as individuals. In the project described by Colley & Stead (2003), a student's desire to work collaboratively and to share information has been integrated into a group activity encouraging learners to develop a virtual map, and allowing them to attach photographs, text, and audio clips gathered during a mobile activity exploring a geographic area.

3.6. Conversation Theory

> 'Learning is a continual conversation: with the external world and its artefacts, with oneself, and also with other learners and teachers. The most successful learning comes when the learner is in control of the activity, able to test ideas by performing experiments, ask questions, collaborate with other people, seek out new knowledge, and plan new actions.' (Sharples, Corlett & Westmancott, 2002, p. 225)

Sharples (2000) considers Conversation Theory, as proposed by Pask (1976), as a primary element to mobile learning, to be supplemented by a detailed analysis of the cognitive, social, and cultural aspects of learning (Jarvis, Holford & Griffin, 1998). Acknowledged to be an elaborate and difficult construct, Conversation Theory spans epistemology, educational technology, and cybernetics (Sharples, Corlett & Westmancott, 2002). Simply put, the theory describes learning in terms of conversations between different systems of knowledge. Pask (1976) purposefully draws no distinction between people and interactive systems, such as computer applications; this has the advantage that the theory may be applied equally to human teachers and learners as to computer-based teaching and learning support systems.

Sharples, Corlett, and Westmancott (2002) present a much-simplified version of Pask's (1976) original concept of learning as conversation, demonstrating how a learner comes to construct understanding of their activities. Central to this theory is continual interaction, reflection, and adjustment between the person's thoughts and actions: 'That is the minimum requirement for any person, or any system, to learn: it must be able to converse with itself about what it knows' (Sharples, Corlett, and Westmancott, 2002, p. 224). Moreover, a more effective form of learning is when people are able to converse with each other, interrogating and sharing their descriptions of the current context.

A series of diagrams illustrates these concepts, the first of which is extracted in Figure 12:

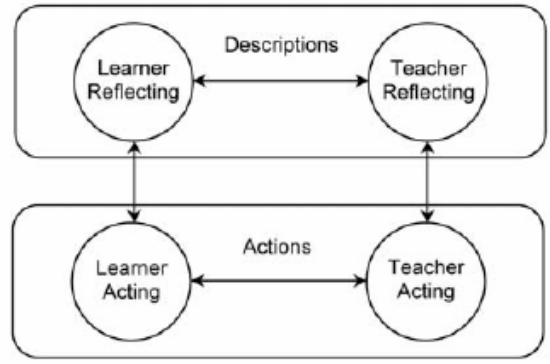

Fig. 2. A framework for conversational learning.

Figure 12: A framework for conversational learning
(Sharples, Corlett, and Westmancott, 2002, p. 224, Figure 2)

As further illustrated in Figure 13, conversation between learner and teacher alternates between specific examples and activities, and explanation and discussion of general principles. Reflective dialogues are also mediated by the environment, and the tools employed, such as notebooks, diaries, concept maps, and logs. Where a student 'learns to learn', reflecting on their activities as a learner, which entails bringing previously-held beliefs into question, and developing a more strategic approach to study, a higher-level active and skilful learning is promoted (Brockbank & McGill, 1998).

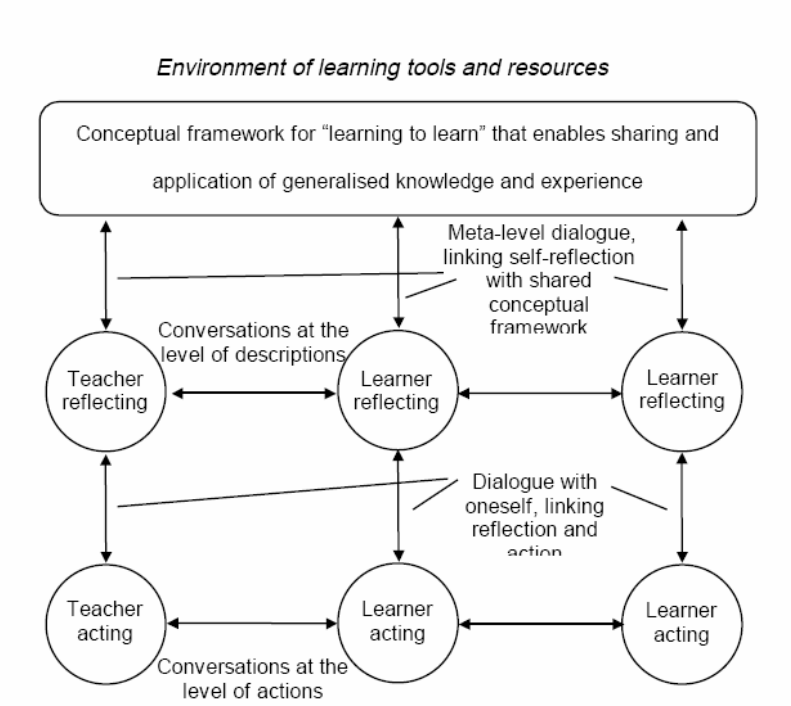

Figure 1. A conversational framework for personal learning

Figure 13: A conversational framework for personal learning (Sharples, 2000, p. 5, Figure 1)

In summary, three 'Cs' serve as central pillars to this theory: construction, conversation, and control. Successful learning is seen as a constructive process (Brown & Campione, 1996), whereby a learner seeks solutions to problems through the ability to relate new experiences to existing knowledge. Conversation between teachers and learners, and learners with themselves, as well as with technologies, is central to Pask's (1976) theory, as concepts are questioned and results reconciled. Finally, learning is most successful when the learner is in control of their own understandings, conducting a continuing cycle of experimentation and reflection (Kolb, 1994).

3.7. Activity Theory

Originating in the work of Soviet scholars Vygotsky (1962, 1978), Luria (1928, 1976), and Leont'ev (1977, 1978, 1981), Activity Theory is axiomatically based on the concept of activity. As an initial formulation, Vygotsky (1978) introduced the notion of the tool as a form of externally-oriented mediated action which will lead to changes in objects.

In the context of mobile learning, technology may be seen as such a tool. Combining Vygotsky's (1978) theory of socio-cultural learning with Luria's (1976) relation-based perspective, Gay, Stefanone, Grace-Martin, and Hembrooke (2001) indicate that context, in the form of classroom structure, tools, and tasks, contribute to and influence the student's experience of learning. In their research applying Activity Theory, the authors endeavour to determine how such contextual influences affect computing behaviour. The answer clearly informs pedagogical approaches, enabling instructional designers and curriculum developers to integrate technologies in the classroom with success.

Acknowledged as the first scholar to adopt Activity Theory outside the Soviet Union, Engestrøm (1987, 2000) developed an extended model of an activity, adding the component of community ('those who share the same object'), whose rules will mediate between subject and community, and whose division of labour will mediate between object and community. As represented by Crawford (2004), Engestrøm (1987, 2000) stresses the importance of individuals and groups taking actions to make explicit, to review, and to question the origins of values and beliefs. The benefit of Engstrøm (2000), according to Laouris and Eteokleous (2005), is to add social context and cultural aspects to the initial theory.

3.8. Relationality

In discussing 'pervasive, persuasive' learning in the electronic domain, Thomas (2005) relies on the notion of relationality to provide support for the proposed model. In short, relationality is about 'providing learners with meaningful and relevant learning situations they can *relate* to' (p. 4). Pervasive learning is seen to have the potential to engage learners in activities in which 1) they can relate to (past experience/indexing); and 2) that they can *relate to their lives* (transfer). Attributes which contribute to relationality include one's personal environment, personal goals, and personal meaning given to specific contexts and situations.

Thomas (2005) relies on current cognitive theory, which explains that knowledge is indexed to the contexts in which an individual encounters it ('indexicalizing' knowledge) (Collins, Brown & Holum, 1991). An instructional designer therefore must create situations for learners which will let them appreciate the value of the information they are exposed to, and be able to apply that information in appropriate contexts later on. Learners will find meaning in personal spaces, where they have the opportunity to practise, experiment, and learn outcomes under conditions which they can relate to (Grabinger & Dunlap, 1995). Grabinger and Dunlap (1995) emphasise the importance of placing learning in broad, realistic contexts, rather than in decontextualised, compartmentalised situations. Acknowledging that meaning changes as location and context changes, mobile learning materials should be 'tailored learning experiences' (Thomas, 2005, p. 4):

> 'Changing personal environments, goals and meanings all work together to help learners understand better the implications of what they are learning and help them to construct ways to relate this knowledge in their lives.' (Thomas, 2005, p. 5)

Learner-centred goal setting is also a necessary principle of relational design (Gagne, 1965). In mobile learning to a large extent, learners may guide themselves through environments, choosing their own paths of learning, and dictating the shape of their knowledge (Thomas, 2005, p. 4). The freedom and flexibility offered by mobile learning environments allows learners to be self-directed, defining their own goals, aims and objectives, both explicit and implicit. With the proposed pervasive learning environment, Thomas (2005) sees the potential to achieve what e-learning always promised: always-on learning, accessible to the masses, but tailored to the individual.

> 'Learner-centred goals are critical because learners "cannot actively construct and evolve their knowledge structures without taking responsibility and initiative for their learning".' (Thomas, 2005, p. 4)

3.9. Contextual Life-long Learning

Sharples, Corlett, and Westmancott (2002) present a framework for the design and implementation of a mobile learning resource which emphasises the importance of Contextual Life-long Learning (CoLL) (Sharples, 2000). The defining features of CoLL are cited as being:

- Learning is not confined to pre-specified times or places, but happens whenever there is a break in the flow of routine daily performance and a person reflects on the current situation, resolves to address a problem, to share an idea, or to gain an understanding;
- Formal education cannot provide people with all the knowledge and skills they need to prosper throughout a lifetime. Therefore, people will need continually to enhance their abilities, in order to address immediate problems and to participate in a process of continuing vocational and professional development. (p. 220)

A corollary of this concept is that the environments where CoLL may occur cannot be pre-specified; these are created through the activity of learning itself. Learners dynamically construct their learning environment, and are central to it. The learner's context will include time, location, and the student's pre-existing knowledge, skills, and resources available.

Requirements for technologies which support CoLL are indicated by Sharples, Corlett, and Westmancott (2002) as needing to be:

- *Highly portable*, so that they can be available whenever the user needs to learn;
- *Individual*, adapting to the learner's abilities, knowledge and learning styles and designed to support personal learning, rather than general office work;
- *Unobtrusive*, so that the learner can capture situations and retrieve knowledge without the technology obtruding on the situation;
- *Available anywhere*, to enable communication with teachers, experts and peers;
- *Adaptable* to the context of learning and the learner's evolving skills and knowledge;
- *Persistent*, to manage learning throughout a lifetime, so that the learner's personal accumulation of resources and knowledge will be immediately accessible despite changes in technology;
- *Useful*, suited to everyday needs for communication, reference, work and learning;
- *Easy to use* by people with no previous experience of the technology. (p. 223)

In Sharples (2000), the author seeks to equip students with personal tools, such as memory aids, concept and topic maps, case archives and communication devices which manifest these traits. Some of the above requirements may be satisfied by traditional tools and methods for organising learning, such as textbooks, notebooks, study guides, timetables, course notes, pencils, and diaries. New technologies are seen to be able to supplement these traditional tools by affording learners the opportunity to 'manage their learning over longer periods of time, to engage in worldwide collaboration, and to relate near-unlimited information to situated problems' (Sharples, 2000, p. 3).

As endorsed by Firmin & Miller (2005), encouragement of a culture of life-long learning is beneficial to both the student and the community, given the high probability that these students so motivated will succeed. A positive attitude to

learning is reported as being critical to the retention and success of students engaged in further education (Firmin & Miller, 2005).

3.10. Enhancement of Other Literacies

Beyond the general gains of life-long learning (Firmin & Miller, 2005), it has been reported that mobile learning with palmtops may assist students with information and numerical literacy (Savill-Smith & Kent, 2003). Information literacy has been described by Pownell and Bailey (2000) as 'an information-age problem-solving process resulting in [the] productive use of information,' and is considered to be at the heart of life-long learning. With reference to Bailey and Lumley (1999), Pownell and Bailey (2000) state further that 'In the coming century, the ability to identify, access, apply, and create information will be the equivalent of literacy.'

As reported by Savill-Smith and Kent (2003), several projects conducted with handheld technology in the United Kingdom have examined the development of literacy skills (Robertson, Calder, Fung, Jones & O'Shea, 1997; Fung, Hennessy & O'Shea, 1998; Hennessy, 1998; McTaggart, 1997; Pyke, 1997; TTA, 2001; and O'Grady, 2003).

Numerical literacy has been explored through the application of graphical techniques (Hennessy, 2000). With the observation that the earliest electronic handheld device assisting with numeracy was the pocket calculator, Hennessy's (2000) study involved students collecting data on weather conditions over time, and examined issues such as the ability to work independently.

3.11. Specific Traits of Learners

Changes in learner characteristics have been chronicled by this project's primary researchers Towers, Smith, and Bruns (2005) in their consideration of 'Generation C' (Trendwatching.com, 2005), which they perceive to be the 'missing link' in e-learning environments. Prensky (2001) has previously described the new generation of 'digital natives' and 'digital immigrants', embracing the N-(net) and D-(digital) generations. Oblinger (2003, 2004, 2005) considers the key traits for today's learners as being:

- Digitally literate;
- Always on;
- Mobile;
- Experimental;
- Community-oriented.

The unique characteristics of the millennial student, as those learners born in or after 1982 (Oblinger, 2003; Oblinger, 2004; Oblinger & Oblinger, 2005; McMahon & Pospisil, 2005; Jonas-Dwyer & Pospisil, 2004; Howe & Strauss, 2000; Poindexter, 2003; Raines, 2002), are described as being focused on 'connectedness' and social interaction, and as having preference for group-based activities in study and social occasions. Being in possession of an information technology mindset and a highly developed skill in multitasking (McMahon & Pospisil, 2005, p. 421), the generation stays in contact through SMS, mobile phones, chatrooms, and email, whilst simultaneously playing computer games, listening to music, and watching television (Frand, 2000, p. 18; Oblinger, 2003; Rickard & Oblinger, 2003).

The ways in which educators may address the specific characteristics of the millennial student, to engage and inspire their learning, will be considered in Section A of the proposed text.

4.0. MOBILE TECHNOLOGIES AND ARCHITECTURES

This section briefly considers examples of current implementations of mobile learning using specific devices. Advice for implementations is often provided (Barker, Krull & Mallinson, 2005; Chang, Sheu & Chan, 2003, *inter alia*), and will be collated in section 4.8.

As were identified in the course of the m-learning project (section 5.6.2), five broad categories of technology must be considered when implementing an m-learning project; namely, transport, platform, delivery, media technologies, and development languages, as identified in Figure 14:

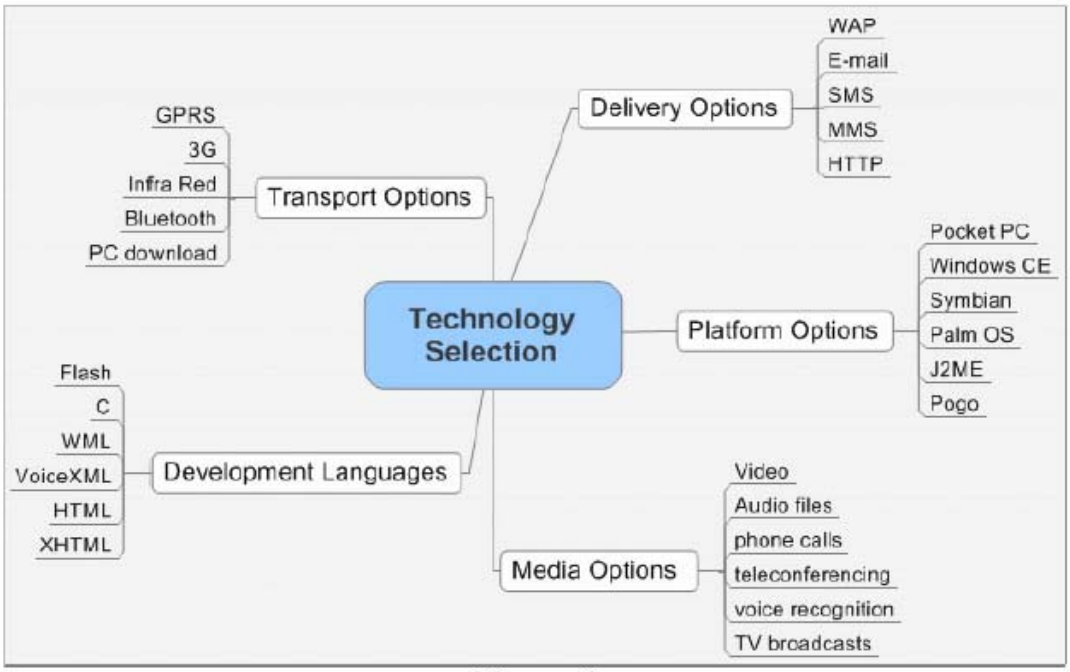

Figure 1

Figure 14: Technology Selection (Attewell, 2005, p. 3, Figure 1)

Bates and Poole (2003) have proposed a model for the effective use of technology for teaching in higher education that suggests eight criteria be used in determining choice of technology. An investigation of whether the right technology has been selected is arguably an important aspect of a comprehensive evaluation of mobile learning. It would therefore have to take account of these criteria, namely:

- The appropriateness of the technology for students;
- Ease of use and reliability;
- Costs;
- Teaching and learning approaches;
- Interactivity;
- Organizational issues;
- Novelty, as a choice not to use existing technology;
- Speed, i.e. how quickly materials can be developed.

The issue of 'access' is to be noted here. The previous model developed by Bates (1988, 1995, cited in Bates & Poole, 2003), had nominated 'access' as one of its key criteria, to denote the provision of flexibility, or, for example, indicating the ability to reach students who could not attend conventional classes. This criterion was subsequently de-emphasised and incorporated into 'appropriateness for students', as above.

Summarising several mobile teaching and learning system implementations discussed at the IEEE Workshop for Wireless and Mobile Technologies in Education 2002, Goh and Kinshuk (2004) tabulate the results as presented in Figure 15. Examining the deployments and evaluations, the authors draw the following conclusions:

a. Mobile learning is in its infancy stage. Researchers are still exploring every aspect of mobile learning.
b. Mobile content can be as simple as SMS to as sophisticated such as multimedia still picture.
c. No video or flash applications on mobile devices were being evaluated.
d. Mobile applications are simple in nature. Most researchers use existing device software such as browser, file transfer, notetaker, voice recorder, or e-mail to conduct their respective experiments.
e. Slightly more sophisticated applications involve technologies using database, Java, Active perl, and forms development.
f. Most applications target directly towards mobile devices. Couple applications started with PC and move to mobile devices with re-design.
g. A variety of mobile devices are being used. These include Nokia communicator, HP-Jornada, IPAQ, and Palm.
h. Most mobile applications are run in mobile and fixed mobile environment.
i. 802.11b wireless networks as well as public telecom infrastructures were used.
j. Discussions on implementation issues were very limited in scope.
k. Most papers target towards evaluating end users experience. (pp. 1- 2)

Reference	Objective	Content	Device	Environment	Implementation Technologies
Waycott (2002)	Impact study	Text	PDA palm m105	Mobile	File transfer
Stone (2002)	Effectiveness of two ways sms	SMS Text	Mobile phone	Mobile	Existing device capability
Vavoula (2002)	Knowledge and learning organisation system (KLEOS)	Text	PC Laptop	Fix mobile	Java application
Seppälä (2002)	Discussion collaborative learning	Text Picture	Nokia Communicator	Mobile	WAP browser Digital picture
Smørdal(2002)	KNOWMOBILE PDA in medical education and clinical practice	Text Voice	PDA, HP Jornada 710/548	Mobile Fixed	Use existing technology Notetaker, offline e-mail, offline web browser, voice recorder, e-book
Milrad (2002)	C-Note Collaborative knowledge building	Text	PDA IPAQ C-PEN Java enable phone PC	Mobile	Sun personal Java, XML, XSL No SWING Cocoon Text base Database
Ketamo (2002a)	x-task Adaptive working environment	Text	PC PDA Nokia 9210	Fixed Mobile	Mysql Active perl Apache web server HTML (simple)
Hsi (2002)	E-guidebook Enhance user experience in a museum	Text Picture	HP Jornada 690/720	Mobile	Web browser RFID 802.11
Attewell (2002)	M-learning Attract young adult to learn	Text	Mobile phone	Mobile	Lecando Server 5 J2EE HTML WAP VoiceXML
Ketamo (2002b)	Geometry game Matching game	Text Graphic	PC IPAQ	Fixed Mobile	Wireless LAN HTML
Chang (2002)	Bird watching Mobile Scaffolding bird watching learning system	Text Picture	IPAQ	Mobile	802.11b Database CE window form Mobile Ad-hoc network

Table 1 Survey of mobile learning systems

Figure 15: Survey of Mobile Learning Systems (Goh & Kinshuk, 2004, p. 7, Table 1)

4.1. Tablet PCs

> 'The Tablet PC acts like a pen and paper, so students can quickly sketch out their ideas. Even sketching complex shapes or writing math equations is easy – something that is an otherwise time-consuming process using a laptop and presentation software or a CAD system.' (Center for Digital Education & Gateway, 2005, citing Microsoft, 2002)

Cortlett and Sharples (2004) describe the trial of wireless tablet PCs with students engaged in higher education. Asked to work with a set of collaboration and knowledge management tools, students were encouraged to explore the functionalities of the tablet PC to support informal elements of their learning, in particular, collaborative group work. The tablet PCs took the form of both clamshell and slate-only with external keyboard; all students within a particular team were allocated the same form factor.

Results of the research conducted by Cortlett and Sharples (2004) concerning patterns of use with tablet PCs indicate that team workspaces have great potential for collaboration, where discussion and document sharing are facilitated. The ability to customise the device is important. Activities supporting team meetings which were facilitated by the technology have included: instant minute-taking and sharing, making an audio recording of the meeting (of particular value to students working in a foreign language), using a shared whiteboard, offering show-and-tell demonstrations of project deliverables, transferring files, and immediately following up requests for emails and project-related information. Generic issues of hardware and software arose; namely, weight and battery life, as well as the instrument's slow performance and unreliable synchronisation of files to departmental file servers were all noted. In addition, the form factor had a distinct impact on students: all students reported that a keyboard is a fundamental element of the use of a tablet PC.

The most popular activities undertaken on the tablet PC were ranked as follows:

1) Email;
2) Creating documents, browsing, listening to music;
3) Reading, taking lecture notes, taking meeting notes;
4) Watching videos;
5) Programming;
6) Internet text messaging, annotating slides;
7) Keeping a record of work, and managing time. (Cortlett & Sharples, 2004, p. 60)

The particular facilitation of these activities is not exclusive to tablet PCs. Rather, Corlett and Sharples (2004) observe, it is the mobility, flexibility, and robustness of this form factor that allows for such uses of ICTs to become embedded in every aspect of informal, collaborative learning. This is considered by both teams and teachers as a positive effect of the introduction of the technology.

The *Higher Education Mobile Learning Handbook*, offered by the Center for Digital Education in collaboration with Gateway (2005), describes projects to implement one-to-one computing across American campuses using tablet PCs. Advantages offered by the tablet PC lie in the fact that students are enabled to organise and search handwritten notes, convert handwriting to text and email, capture text and pictures, and share notes for collaborative work. In addition, lectures can be recorded by the students, and synched with their handwritten notes. Lying flat, the PC does not obstruct the view between lecturer and student, and in that it uses a pen or stylus is quiet, in comparison with the clicking of keyboards. In summary, the Center for Digital Education (2005) sees that tablet PCs are

'positioned as the next probable program choice in the future of portable, wireless computing on campuses' (p. 7).

In a further paper, Deng, Do, Chang, and Chan (2004) introduce a tool known as PuzzleView for group learning with tablet PCs. The authors discuss issues associated with workspace layout of group learning, including analysis, decomposition, enlargement, and group representation tools.

4.2. iPods

Described as a 'bold experiment' (Mellow, 2005), Duke University issued iPods to their first year students in 2004 (Associated Press, 2005). Seven diverse examples have been provided concerning the use of the iPod (Duke, 2004); however, as observed by Cochrane (2005), merely providing technology such as iPods does not guarantee that it will be used in an educational way (Bugeja, 2005). The final evaluation report of Duke's implementation has given rise to the development of the Duke Digital Initiative (Duke, 2005), which focuses on 'experimentation, development, and implementation of digital technology in an academic environment.'

Taking Duke's lead, Drexel University's School of Education has provided iPods for their 2005 intake. William Lynch, director of Drexel's School of Education, has rationalised the decision: 'Rather than resisting a popular technology because it's popular, we want to embrace that as a way to be more effective in communicating.' (Perlman, 2005)

4.3. Palmtop Computers

The term 'palmtop computer' embraces not only PDAs, to be discussed in section 4.4, but also specialised handheld devices, such as e-book readers, dictionaries, spell-checkers, and graphic calculators (Savill-Smith & Kent, 2003, p. 3). As systems tend towards convergence, the distinction between mobile phones, discussed in section 4.5, and palmtops becomes increasingly less obvious (Attewell & Savill-Smith, 2003; Bollen, Eimler & Hoppe, 2004).

The use of palmtop computers in learning is well documented, with the advantages of their application being collated by Savill-Smith and Kent (2003) in their ability to:

- Assist students' motivation;
- Help organisational skills;
- Encourage a sense of responsibility;
- Help support both independent and collaborative learning;
- Act as reference tools;
- Track students' progress;
- Deliver assessment. (p. 5)

4.4. Personal Digital Assistants (PDAs)

Personal Digital Assistants (PDAs), encompassing Palm and PocketPC devices, have found increasing acceptance, and hence proliferation in recent years, owing to the perception of their convenience when compared to traditional PCs and laptops (Cochrane, 2005; Soloway, 2000). Offering the ability to connect to applications such as email, instant messaging, RSS feeds, discussion boards and blogs, and to download courseware and Web pages, PDAs seem primed to be adopted as the mobile learning tool *par excellence*.

Interestingly, research has demonstrated that the features and functionality of PDAs remain underutilised (Singh, Denoue & Das, 2004). Singh, Denoue, and Das (2004) observe that the devices are still primarily used for PIM (Personal Information Management) functions, such as calendaring, observance of to-do lists, and for storing contact information (p. 1). To realise the PDA's full potential, designers and developers are entreated to address their reported difficulty of use, and disconnect between the functionality users require in context, and what is delivered to them (Singh, Denoue & Das, 2004, p. 1).

Advantages held by a PDA in facilitating collaborative m-learning environments include:

- *Portability* – the ability to take the computer to different sites and move around within a location;
- *Social interactivity* – the ability to exchange data and collaborate with others face-to-face;
- *Context sensitivity* – the ability to gather data unique to the current location, environment, and time, including both real and simulated data;
- *Connectivity* – the ability to connect handhelds to data collection devices, other handhelds, and to a common network that creates a true shared environment;
- *Individuality* – the ability to provide unique scaffolding that is customised to the individual's path of investigation. (Squire, Johnson, Holland, Nataf & Klopfer, 2002, p. 7)

Cochrane (2005) considers the PDA's benefit to lie in its small size, its cost compared to other computing devices, and its potential for ubiquitous computing for all students. Disadvantages are cited as the device's small screen size, the WiFi network's security protocols, the need for further development of protocols and support structures within institutions, stability of certain models, tutor acceptance and use/modelling of the new technology, and the imperative to convince students to use the technology in collaborative, educational ways (Cochrane, 2005, p. 152). These potential barriers to the implementation of PDAs have also been noted by Barker, Krull, and Mallison (2005), Thornton and Houser (2004), Vahey and Crawford (2003), and Perry (2003).

In medical practice, where uptake of PDAs is now considered to be prolific (Relan, Parker, Wali, Guiton & Fung, 2004), handheld computers are seen to be gaining a status equivalent to a stethoscope (p. 1). In documenting a three-year study with a leading US medical school, and noting recommendations that two other medical schools employ the technology (Crowell & Shaw-Kokot, 2003; Moffett, Menon, Meites, Kush, Lin, Grappone & Lowe, 2003), the authors 'explicate the complexity of diffusing a nomadic technology' (p. 1). While PDAs have been successfully integrated into clinical contexts, the authors convey that their value in medical education as a whole is less unambiguous (p. 1). Overall, the development of a clinical curriculum enhanced by PDAs is endorsed by the authors, noting that:

a. Students must model the growing number of clinicians adopting PDA's to support their clinical decision making, patient tracking, consultation of etexts, drug and other databases;
b. Students must develop skills needed to be effective physicians of the future, who will be expected to be well versed in the use of mobile technologies as corroborated by the Association of American Medical Colleges graduation questionnaire to all medical students, reflecting on their confidence in the use of mobile technologies;
c. The school needs to facilitate standardization of the clinical curriculum via data collection in a highly unstructured learning environment;

d. The didactic quality of clinical clerkships must improve via greater and better feedback to students' knowledge during the clerkship years.
e. Enhance students' clinical decision making skills and knowledge during the clerkship years. (p. 3)

As documented by Relan, Parker, Wali, Guiton, and Fung (2004), PDAs have been used in clinical settings to assist physicians with the recall and application of exponentially increasing medical knowledge; to provide comprehensive drug information on dosage, interactions, and the efficacy of new drugs; to serve as a data gathering tool for research, evaluation, and teaching; to provide a tool for acquiring knowledge via practice and feedback; and to act as a consultation platform for paediatric charts, ECGs, and clinical guidelines across virtually every specialty (pp. 1-2). The implementation has also been considered by Smørdal and Gregory (2003).

In further discipline-specific fields, Skalsky and Pastel (2004) investigate a PDA-based laboratory for scientific experiments, exploring the potential of the devices for graphical data presentation and analysis. Frohberg (2004) notes the potential of the device for delivery of MBA course material.

4.5. Mobile Phones and SMS

> 'The heightened interest in mobile possibilities for teaching, learning, and research can be attributed to a number of factors: the continuing expansion of broadband wireless networks; the explosion of power and capacity of the next generation of cellular phones; and the fact that mobile telephones, a familiar tool for communications, are already full ingrained in contemporary life as part of our social practice.' (Wagner, 2005, p. 43)

Statistics cited by Armatas, Holt, and Rice (2005) concerning the current uptake of mobile phones in Australia indicate that market penetration stood at 73% in 2003, and is projected to increase (Telstra, 2005). Figures from the United Kingdom, Italy, and Sweden, as documented by Attewell and Savill-Smith (2003, based on Brown & Dhaliwal, 2002), reveal that mobile ownership among 15-24 year olds averaged at approximately 90% in 2002. The marked diffusion of this technology makes it ideal for the dissemination and collection of content for educational purposes.

The extent to which university students in Japan are already using mobile phones to coordinate and communicate with each other has been assessed by Thornton and Houser (2004) across three projects. Given the perceived popularity of the devices (100% of 300 students polled owned a mobile), the researchers wished to assess their educational potential. When the researches suggested that students receive information about their classes via mobile phones, the cohort reacted positively, perceiving this to be an important potential use of SMS technologies (Thornton & Houser, 2004, p. 7).

The review of literature on the use of the Short Messaging System (SMS) in education demonstrates a groundswell of positive feedback from students (Cheung, 2004; Faulker, 2004; Gonzales, Ittelson & Krebs, 2004). SMS technology may be employed according to three models within m-learning (Geddes, 2004). As specified by Mellow (2005), these will be in the form of:

i. *A 'Push' system*, where the institution pushes out messages to all students in a course. Cost is to the institution and using an example of a paper with 200 students receiving four text messages in a week, the cost would be $1,000 a semester. This may be useful for course announcements (e.g. exam room change, tutorial cancellation).

However, with study notes, not all students would want, or use the information contained in that message and it could be perceived as 'mobile phone Spam'. The question also arises; do we require informed consent to deliver these messages to the students?

ii. *A 'Pull' system*, where students order specific information based on a menu of all listed content on a web page or a paper handout. Cost is per message to the student. This is similar to ordering a ring tone or a screen tattoo for their phone.

iii. *An interactive model*, where questions are either sent out or ordered, then answered, and replied to by the student to check the answers and receive feedback. This is the most expensive model as it may require many messages back and forth, leading costs to rise. (p. 471)

Current SMS implementations involve the 'push' variety, and no university is known to have implemented the 'pull' model to date (Mellow, 2005). Whilst there may be concerns of the level of 'spamming', SMS offers the following key advantages to students, identified by Mellow (2005):

- True flexibility to control the time, place and pace of their learning;
- Specificity of content;
- Tutor-constructed study aids designed for those areas that are 'challenging to learn';
- Using technology that is engaging and totally comfortable for the student;
- Non-threatening, private availability of on-demand study support. (p. 473)

In considering support for first-year university students, Stone (2004) reports that SMS has been identified and employed as a form of 'mobile scaffolding', explicitly addressing issues of student retention.

Facilities encompassing the advantages of text, image, and sound have been proposed by Benta, Cremene, and Padurean (2004) in their use of the Multimedia Messaging Service (MMS), transmitting pages encoded in Wireless Markup Language (WML). The authors envisage that as the project develops, artificial intelligence (AI) and location-based features will be considered, as well as an extension to the existing database. Armatas, Holt, and Rice (2005) list the first benefit of the judicious use of mobile technologies as being to deliver multimedia materials designed specifically for the mobile device, and interactive tasks, such as online quizzes (p. 29).

The development of Mobile Interactive Learning Objects (MILOs) for use within a Mobile Learning Engine (MLE) is discussed by Holzinger, Nischelwitzer, and Meisenberger (2005). Acknowledging the mobile phone's ability to deliver learning objects to students, and to provide access to online systems and services, Attewell (2005) observes that handheld devices have clearly surpassed the point where they were used simply for chatting and organising contacts and diaries. The current limitations of network infrastructure and bandwidth are now the barrier to use (Attewell, 2005, p. 16).

4.6. Wireless Infrastructure

Advantages of the integration of wireless computing into education are ubiquity, portability, and flexibility for collaborative learning projects (Sotillo, 2003). It has been said that the wireless revolution is already here (Alexander, 2004), driven by the proliferation of wireless consumer devices, burgeoning wireless hotspots, and the falling costs of wireless access point hardware (Cochrane, 2005; Baldzer, Boll, Klante, Krösche, Meyer, Rump, Scherp & Appelrath, 2004). Affording 24/7 access irrespective of location, the scope for the application of wireless communication and services is vast (Falk, 2003; Lu, Chun-Sheng, Chang & Yao,

2003), and novel distance learning applications are likely to be in the offing (Hui, Fong & Lau, 2003; Chen & Kinshuk, 2005).

Project documentation associated with the e-learning to m-learning project (section 5.6.3) provides the most comprehensive consideration of the advantages and disadvantages of using WAP (Wireless Application Protocol) in developing an m-learning course. Designed to accommodate the current limitations of network, device, and user interface, WAP is optimised for mobile networks with narrow bandwidths, mobile devices with small screens, limited keys to user entry, minimal memory storage and limited processing and battery power. The authors conclude that this makes WAP an ideal choice for developing an application for m-learning. With handset developers and mobile phone manufacturers committing to the protocol, and WAP supporting positioning and personalisation, going wireless appears to be a logical choice.

There are, however, disadvantages to implementing wireless networks, mostly deriving from the devices themselves. Limitations mostly relate to the sending and receiving of animations and detailed coloured images, and the cost of the devices. Networks are often slow, but are set to improve with development into 3G and 4G. Designers and developers need to take the current state of play into account, however, when implementing these tools. A simple set of rules has been propounded:

1. Keep it simple;
2. Avoid large amounts of data;
3. Avoid underlined text, as this will be mistaken for links;
4. Use selection lists for data entry;
5. For consistency, place links in the same place throughout an application;
6. Always provide a link to the start page or index;
7. Use titles on cards to ease navigation;
8. Use tabloid format, with headlines and summaries;
9. Use short words. (http://learning.ericsson.net/mlearning2/project_one/wap_article.html, 19/01/2006)

Acknowledging that the manner in which curriculum content and mobile materials are delivered over wireless networks and then assessed will need to be addressed, O'Nuallian and Brennan (2004) propose a conceptual architecture, MoDCA, which applies a user-centred learning and assessment approach. This model takes into account the pedagogical aspects of learning, the psychology of collaboration, the heterogeneous nature of mobile devices, and the importance of effective assessment. In addition, authors Chen & Kinshuk (2005) undertake a formative system evaluation to test the feasibility of providing mobile educational services to tertiary-level learners, where valuable participant perception of system functionality was gleaned.

In an attempt to answer the challenge of teaching a large class, Mercier, David, Chalon, and Berthet (2004) describe the DRIM-AP (translated as 'Multiple Interactive Radio Devices and Participative Lecture Theatres') project, exploring the principle of an interactive large class using wireless devices. In large-scale lectures, students are able to use wireless devices to communicate in real-time with the lecturer, sending instantaneous feedback, and responding to quizzes and polls. Lecturers are able to monitor class progress through a laptop computer. The authors determine that from a technical point of view, existing wireless technologies are suitable to bring interactivity into lectures presented to large classes (Mercier, David, Chalon & Berthet, 2004, p. 131). What remains is to evaluate the cognitive impact and usability of said system during teaching

activities, and to release a version of the DRIM-AP software to the wider educational community.

As noted by Dawabi, Wessner, and Neuhold (2003), the quality of mobile learning scenarios will vary in many ways, including synchronicity, local distribution, group size, and efficiency.

4.7. Learning Management Systems (LMS)

The definition of a Learning Management System (LMS), also known as Course Management System, Managed Learning Environment, or Virtual Learning Environment, has been provided by Paulsen (2003):

> 'Learning Management System is a broad term that is used for a wide range of systems that organize and provide access to online learning services for students, teachers, and administrators. These services usually include access control, provision of learning content, communication tools, and administration of user groups. Another term that often is used as a synonym for LMS is learning platform.'

In evaluating options for the Queensland University of Technology's Learning Management System, Obexer and Bakharia (2005) observe that LMSs have reached a point in higher education where they are integral, if not mission critical, elements of a university's teaching and learning infrastructure. Supporting not only pedagogical undertakings, LMSs are major enterprise systems, offering administration and management functions in close collaboration with other university systems, such as student management systems and library systems.

Available functionalities of LMSs typically include folder creation, file uploading, content creation and editing (via a WYSIWYG editor), copying tools, the ability to add URLs, delayed and conditional release of materials, search facilities, and sequencing of content and tools.

As collated by Obexer and Bakharia (2005, p. 16), to support appropriate pedagogical approaches, LMSs are required to:

- Put more emphasis on the learner and his/her actions in the learning process by incorporating effective learner tools and spaces;
- Allow for networked learning through easy collaboration and communication tools;
- Allow for the learner's creation, management and transmission of content/knowledge;
- Support ubiquitous access for learners to resources and people;
- Go beyond the limitations of a unit/course paradigm and allow for a variety of learning spaces and interdisciplinarity;
- Allow for effective assessment, including tracking and reporting (also for the learner);
- Seamlessly integrate with other applications.

In terms of a LMS's integration with mobile technologies, there are to date few implementations able to be cited. Difficulties in implementation include the diversity of devices available with which to couple, and lack of standards for transmission networks. Mellow (2005) notes that

> 'Many universities have caught the first wave of electronic flexible learning by offering content, facilitated discussion activities, collaboration, and communication online with a range of learning management systems (LMS, e.g. Blackboard, WebCT, Moodle, etc.) LMS offer real options to students, but still rely on a computer terminal to interface with this material.' (p. 470)

4.8. Implementation of Mobile Learning

When considering the implementation of mobile devices, universities must consider their fit within the current curriculum: Keegan (2003) observes that not all teaching is suited to the m-learning environment, where a preference should be given to short courses and theory- and information-based classes. Clearly, adoption of mobile learning in the university context will be influenced by organisational, socio-cultural, and intra- and interpersonal factors, *inter alia* (Elgort, 2005).

Becta (2004) suggests that educational institutions need to contemplate whether they can provide the training and technical support required for mobile learning implementation, and moreover, that all stakeholders should be involved in the development of the adoption plans (Wood, 2003).

Valuable lessons learned from the implementation of the m-learning project have been provided by Attewell (2005):

- A mixture of online learning and learning using materials previously downloaded onto handheld devices helps to reduce costs and the inconvenience of signal disruption whilst traveling or poor signal in some remote rural areas.
- The use of software layers to insulate learning materials from device-specific features and delivering learning materials in a browser helps overcome some lack-of-standards issues but does not offer full platform independence.
- Attempting to deliver a monolithic mobile learning system leads to inflexibility, limits ability to take full advantage of the heterogeneous mixture of hardware and services available and detracts from facilitating blended approaches to learning delivery.
- An iterative approach to development informed by learner feedback results in better learning materials and systems.
- Whilst it is possible to re-purpose learning materials developed for PC delivery to run on mobile devices, this approach may not make best use of the strengths of the mobile technologies.
- A flexible, collaborative and pragmatic approach to development works well in an environment where the technologies are new and standards are evolving. This is aided by working within a small consortium.
- It is important to be aware that, when delivering learning or offering support services to learners' mobile phones, one is encroaching on their personal space.
- For our target audience teacher/mentor enthusiasm and involvement seem to be very important for successful mobile learning.
- Sufficient training preceded by training needs analysis is important for teachers/mentors as mobile literacy and confidence varies.
- Fast response to mentor and learner problems is crucial to avoid disillusionment and stalling momentum and proactive support for those just starting to support mobile learning plus ongoing access to advice is helpful. (p. 5)

A holistic model for m-learning adoption has been proposed by Barker, Krull, and Mallinson (2005), as represented in Figure 16. This framework embraces the traditional learning environment and is clearly supported by appropriate m-learning policies and guidelines. As indicated, the traditional learning environment is one in which learning may still take place via desktop PCs. Within the m-learning environment, the communications infrastructure, here represented by a dotted line, contains wireless access points enabling communication among the mobile devices, notably mobile phones, PDAs, and wireless handheld devices. Barker, Krull, and Mallinson's (2005) proposed model demonstrates that mobile devices can be applied as academic support for learners via online assessment, delivering course content, and access to the Internet. These devices also enable learner-to-learner interpersonal communication, as well as learner-to-teacher interaction. In sum, essential elements of a mobile learning environment, as put forward by Chang, Sheu, and Chan (2003), are encompassed: teachers, learners, learning and instructional mobile devices, and a communications infrastructure.

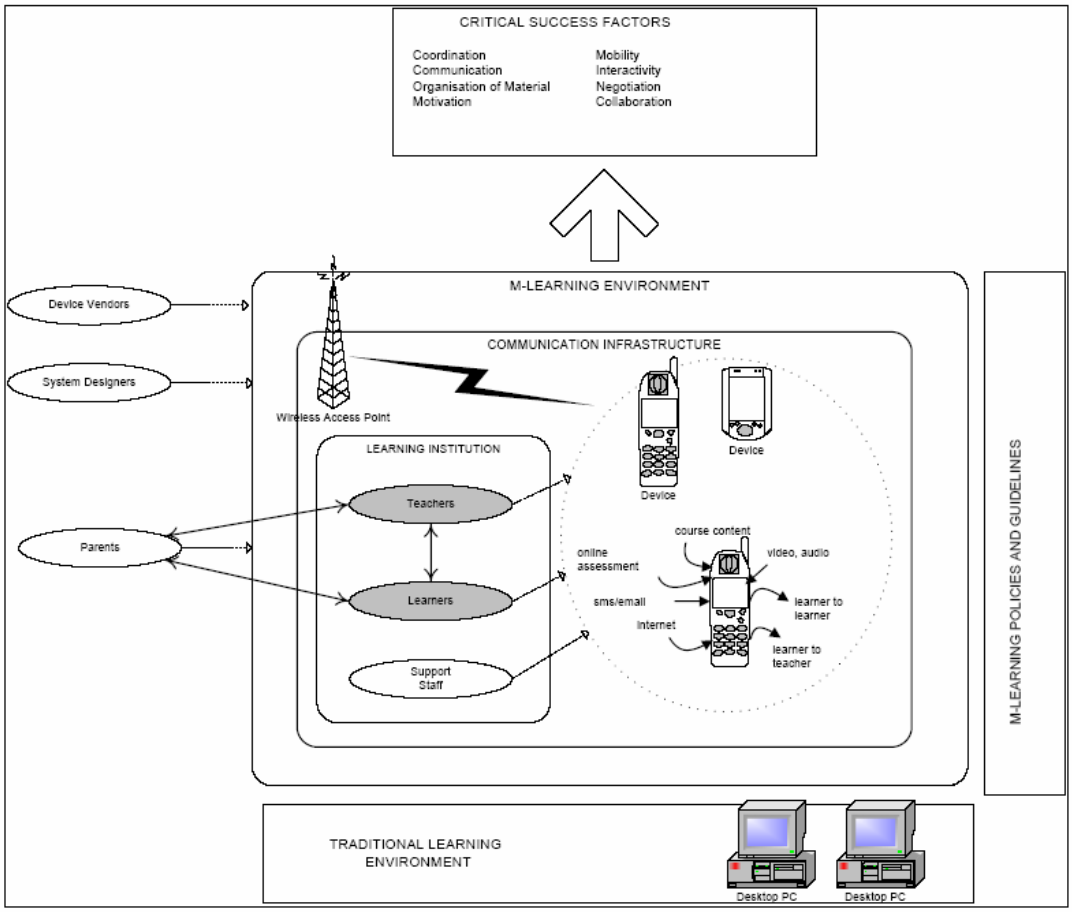

Figure 1: Model for M-learning Adoption

Figure 16: Model for M-Learning Adoption (Barker, Krull & Mallinson, 2005, p. 7, Figure 1)

4.9. Critical Success Factors

In the model proposed by Barker, Krull, and Mallinson (2005), as seen in Figure 16, critical success factors are derived from the work of Zurita, Nussbaum and Sharples (2003), as the collaborative learning components which determine the successful adoption of mobile learning. These are interactivity, coordination, negotiation and communication, organisation of material, and mobility, and have been extended to embrace motivation and collaboration. Considered separately, these factors are construed in a user-centric manner, and may be seen to support Ramsden's (1992) six principles of effective university teaching, which embrace: interest and explanation; concern and respect for students and their learning; appropriate assessment and feedback; clear goals and intellectual challenge; independence, control, and engagement; and learning from students.

Essential for the adoption of the project, the critical success factors are:

- *Interactivity*: refers to the amount of interaction between learners using mobile devices, and the extent to which using handhelds force learners to share information in a learning activity;
- *Coordination*: refers to the use of mobile devices encouraging active participation by all learners and a need to coordinate activities;
- *Negotiation and Communication*: Using handhelds allows for negotiation between learners within group activities, as a consensus needs to be reached before moving on to another activity. Communication implies that a mobile learning environment needs to open the channels of communication between learners, and with their teacher;
- *Organisation of material*: is essential for the learner to be able to employ appropriate information-seeking behaviours;
- *Mobility*: refers to the portability of the devices and the extent to which they enable the mobility of the learners;
- *Motivation*: implies the extent to which the m-learning environment motivates learners to engage with their learning and encourages teachers to develop innovative ways of using the devices to complement traditional teaching methods;
- *Collaboration*: refers to the m-learning environment promoting partnership between learners and teachers. (Barker, Krull & Mallinson, 2005, p. 8)

4.10. Evaluation and Quality Assurance

The authors of *Mobile Learning: A Handbook for Educators and Trainers*, Kukulska-Hulme and Traxler (2005), have provided an excellent impetus for educators, researchers and policy makers to integrate notions of evaluation and quality assurance into the development and implementations of m-learning technologies.

Attributes characterising 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 the nuances of evolving 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 all 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.

  (Traxler & Kukulska-Hulme, 2005, p. 2)

The guidance provided by these acclaimed authors should provide the framework for the implementation of successful evaluation and Quality Assurance structures in tertiary education in respect to mobile learning.

4.11. University Policy Development

> 'Mobile technologies provide for each student to have a personal interaction with the technology in an authentic and appropriate context of use. This does not mean, however, that the use of mobile devices is a panacea. Significant technological and administrative challenges are encountered along with a more ill-defined challenge: how can the use of mobile technologies help today's educators to embrace a truly learner-centred approach to learning?'
> (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 32)

Invaluable insight into the current context in which universities operate with respect to the provision of online teaching and blended learning is provided by Williams and Goldberg (2005) from the influential Universitas 21 at ASCILITE 2005. Presenting the changing trends facing the tertiary sector, namely, a significant growth in the number of students studying part-time and through distance learning, dramatic increase in non-traditional learners beyond the 18-24 year-old demographic, the recognition of the essentiality of lifelong learning, the return of women to the workforce and a burgeoning aging population, the authors comment that it is not surprising that

> 'Flexible delivery has become something of a mantra for tertiary educational institutions as they seek to satisfy these non-traditional students while also tapping into new and global opportunities' (p. 725).

Seeking a pedagogy that is 'interactive, engaging, and capable of producing deep learning outcomes for a greatly expanded population of learners, locally, nationally, and increasingly, globally' (p. 726), the authors perceive sophisticated, ICT-supported learning as the way forward for sustainability and success.

Pedagogically sound guidelines for the adoption of mobile learning are offered by Vavoula, Lefrere, O'Malley, Sharples, and Taylor (2004), to be of use for systems designers, in advising them of the settings and scenarios in which mobile technologies will be employed, and the manifold issues arising from the deployment with teachers and learners. The guidelines encompass recognition of key stakeholder needs: perspective for policy makers should be derived from both learners and teachers, as theory-informed 'do and don'ts' validated and segmented by target audience. Noble (1998) endorses a consultative process in the development of programs, perceiving that 'The high-tech transformation of higher education is being initiated and implemented from the top down, either without student and faculty involvement in the decision-making or despite it' (in Tarragó, 2003).

Seeking empirical evidence as to the adherence to existing guidelines, and acknowledging the importance of keeping context in mind, Vavoula, Sharples, O'Malley and Taylor (2004) are seeking to produce a database of checklists, policies, and guidelines as part of the MOBIlearn project (see section 5.6), which will evolve as projects are documented and reported.

An evolution of organisational and management questions from the e-learning to the m-learning context is conceivable, as McGovern and Gray (2005) contemplate the implications from a qualitative survey on online learning at RMIT. Broad questions concerning the implementation of blended learning may therefore be classified as follows, where 'online' is replaced by 'mobile':

i. *Implications for the learning experience*. From the student perspective, what are useful [mobile] learning resources and activities? What is the best mix of [mobile] and face-to-face? Should notes be electronically distributed, or are they best provided in printed form? Should [m]-learning be mandatory, or optional?
ii. *Implications for teaching practices*. Given that one-on-one instructional design and courseware development support is not possible, what can a wide range of staff do that provides useful [mobile] learning support for their students? Do they need to have their work quality assured? Can they use the available tools? Do the environments meet their needs? What professional development do they need to adopt [m]-learning?
iii. *Implications for technology planning*. What functionality must the technology support? Is a single comprehensive LMS adequate? If not, what other tools are needed? Will an incremental approach to improving functionality be sufficient to meet student expectations?
iv. *Implications for university sustainability*. What is [m]-learning doing for the university as a whole? Does it support the [university's] strategic direction, including its teaching and learning strategy? Is it improving the outcomes for students? Is it reducing costs or generating new revenue? (p. 390)

An objective economic evaluation of mobile learning is provided by Traxler (2003), who introduces the concept of cost estimation in order that institutions may accurately model the implications of their programs. With cost modelling, Traxler (2003) highlights the importance of establishing foundations for understanding the basis of commercial exploitation.

4.12. Academic Development

Several papers have dealt specifically with the notion of professional development for staff in relation to the implementation of mobile technologies both in and beyond the classroom. Given the 'complex, challenging, and ongoing process' of developing and employing mediated learning environments (Lloyd & Irvine, 2005, p. 378), it remains critical to acknowledge that technical mastery is not the only adoption issue facing academics (Liu, Theodore & Lavelle, 2004). McNaught and Vogel (2004) emphasise that the attempt to keep pace with innovations in teaching and learning, such as conferencing technologies, message-based interactions, synchronous and asynchronous interfaces, wireless communications, electronic response systems, and streaming technologies will put academics under considerable stress if they try to keep up with even a small percentage of the more useful of these technologies for their own discipline.

The demands of increased or altered workloads, changed assessment requirements and procedures, questions of student engagement (Britain & Lieber, 2000; Ellis & Phelps, 2000), increased time commitments, and lack of incentives and support (Newton, 2003) all have their part to play in the new dynamic. Finding the balance between technology and the human aspect to innovative environments so as to achieve learning objectives and to 'maintain fidelity with existing beliefs about teaching and learning as [lecturers] come to terms with an emergent digital pedagogy' (Lloyd & Irvine, 2005, p. 378), is an ongoing concern. In an endorsement of this, Applebee, McShane, Sheely, and Ellis (2005) call for a sustainable approach to academic development in the e-environment. As argued by McNaught, Lam, Keing and Cheng (2005, p. 16), programs of academic development can build 'awareness in teachers about a wider range of strengths, weaknesses, potentials, and strategies' of learning in the electronic environment, and enable them to construct better environments overall. This task should be given high priority by academic developers who work in the area of m-learning.

In addition, the proceedings of the IFIP TC3/WG3.1 & WG 3.3 Working Conference on ICT and the Teacher of the Future held from January 27-31, 2003, in Melbourne, titled *Information and Communication Technology and The Teacher of the Future* (Dowling & Lai, 2003) reflect the concerns of teacher education for online literacy. In particular, the presentations of Jones (2003), Law (2003), Morel, Domenjoz, Lachat, and Rossi (2003), and Romeo (2003) reflect the concern that, in preparing for electronic educational contexts and the shift in paradigm from teacher- to learner-centric materials, 'technology matters but good teachers matter more' (Romeo, 2003, p. 191).

> 'A robust environment in which reliable and immediate technical support is available and an industrial environment which is considerate of altered work practices and conditions emerge as fundamental factors in the success of individuals adopting and developing effective mediated learning environments.' (Lloyd & Irvine, 2005, p. 378)

5.0. BIBLIOGRAPHIC INFORMATION

5.1. Sources

In considering the current writings in the field of mobile learning, and as a corollary electronic, online, and distance learning, together with publications on the philosophies and practices of teaching, as well as detailed technical descriptions of devices, several key sources of information have been identified. In the following subsections, the relevant conferences, projects, and research institutions will be identified.

In the course of conducting this literature review, several significant assemblages of resources have been identified. As documented by Attewell and Savill-Smith (2003), the m-learning project under the aegis of the Learning and Skills Development Agency (LSDA) (section 5.6.2), investigated the context of mobile learning by conducting environmental scans into:

- Mobile phones, their uses and users (Attewell & Savill-Smith, 2003;
- The use of palmtop computers for learning (Savill-Smith & Kent, 2003);
- The use of computer/video games for learning (Mitchell & Savill-Smith, 2004). (Attewell & Savill-Smith, 2003, p. 4)

In addition, the NESTA Futurelab has published thirteen reports to date into the impacts of technologies on education, to serve as 'route maps through the vast body of research into education and technology' (http://www.nestafuturelab.org/research/lit_reviews.htm, 19/01/2006). They are enumerated as follows:

1. Report 1: *Literature Review in Languages, Technologies and Learning*;
2. Report 2: *Literature Review in Thinking Skills, Technology and Learning*;
3. Report 3: *Literature Review in Citizenship, Technology and Learning*;
4. Report 4: *Literature Review in Creativity, Technology and Learning*;
5. Report 5: *Literature Review in Primary Science and ICT*;
6. Report 6: *Literature Review in Science Education and the Role of ICT*;
7. Report 7: *Literature Review in Informal Learning with Technology Outside School*;
8. Report 8: *Literature Review in Games and Learning*;
9. Report 9: *Learning with Digital Technologies in Museums, Science Centres and Galleries*;
10. Report 10: *Literature Review of E-assessment*;
11. Report 11: *Literature Review in Mobile Technologies and Learning*;
12. Report 12: *Literature Review in Learning with Tangible Technologies*;
13. Report 13: *14-19 and Digital Technologies: A review of research and projects*.

Recent releases of books dealing with mobile learning include Driscoll, M. & Carliner, S. (2005). *Advanced Web-Based Training Strategies*. San Francisco: Pfeiffer, where Chapter Eight deals specifically with m-learning; and Traxler, J. & Kukulska-Hulme, A. (2005). *Mobile Learning: A Handbook for Educators and Trainers*. London: RoutledgeFalmer.

5.2. Primary Research Institutions

In addition to the NESTA Futurelab, key research institutions contributing findings to the nascent m-learning discipline have been identified as the University of Birmingham Centre for Educational Technology and Distance Learning (CETDL),

and the Learning Skills Development Agency (LSDA), as is manifest in section 5.4 primary contributors, below. Becta, the British Educational Communications and Technology Agency (http://www.becta.org.uk/), provides a technology for e-learning resource bank, and supports many initiatives.

5.3. Primary Journals

Key journals in this area have been identified as *British Journal of Education Technology*, *Communications of the ACM*, *Computers and Education*, *Computer Science Education*, *Educational Research & Evaluation*, *EDUCAUSE Quarterly*, *EDUCAUSE Review*, *Interactive Learning Environments*, *International Journal of Artificial Intelligence in Education*, *International Journal of Human-Computer Interaction*, *Issues in Informing Science and Information Technology*, *Journal of Computer Assisted Learning*, *Journal of Educational Multimedia and Hypermedia*, *Personal and Ubiquitous Computing Journal*.

5.4. Primary Contributors

Key contributors to the field of mobile learning have been identified, alphabetically:

- Bryan Alexander (*Center for Educational Technology at Middlebury College*);
- Jill Attewell (*Learning and Skills Development Agency*);
- Dan Corlett (*University of Birmingham Centre for Educational Technology and Distance Learning*);
- Agnes Kukulksa-Hulme (*Open University*);
- Peter Lonsdale (*University of Birmingham Centre for Educational Technology and Distance Learning*);
- Alice Mitchell (*Anglia Polytechnic University, United Kingdom*);
- Laura Naismith (*University of Birmingham Centre for Educational Technology and Distance Learning*);
- Miguel Nussbaum (*School of Psychology, Catholic University of Chile*);
- Kristóf Nyíri (*Institute for Philosophical Research of the Hungarian Academy of Sciences*);
- Carol Savill-Smith (*Learning and Skills Development Agency*);
- Mike Sharples (*University of Birmingham Centre for Educational Technology and Distance Learning*);
- Siobhan Thomas (*Institute of Education, London*);
- John Traxler (*Wolverhampton University Centre for Learning and Teaching*);
- Giasemi Vavoula (*University of Birmingham Centre for Educational Technology and Distance Learning*);
- Ellen Wagner (*Global Education Solutions at Macromedia*);
- Gustavo Zurita (*School of Psychology, Catholic University of Chile*).

5.5. Key Conferences

The following are the primary conferences held on the issue of mobile learning and associated information and communication technologies. Additionally, papers have been sought from the IEEE, the ACM (the Association for Computing Machinery), and EDUCAUSE pertaining to other gatherings.

- ASCILITE: Australian Society for Computers in Learning in Tertiary Education: http://www.ascilite.org.au/

- IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE): http://lttf.ieee.org/wmte2005/
- IEEE International Conference on Pervasive Computing and Communications (PerCom): http://www.percom.org/
- JISC Online Conference: Innovating e-Learning: http://www.jisc.ac.uk/elp_conference06.html
- M-Learn: http://www.mlearn2006.org/
- IADIS International Conference on Mobile Learning: http://www.iadis.org/ml2006/

5.6. Projects

Several high-profile projects now exist to examine specific implementations of mobile learning, as detailed in the following subsections.

5.6.1. MOBIlearn: http://www.mobilearn.org/

The MOBIlearn project, situated at the University of Birmingham, embraces a consortium of 24 partners (including 14 universities) across Europe, Israel, the USA and Australia, who investigate context-sensitive approaches to informal, problem-based, and workplace learning. MOBIlearn partners participate in the mLearning conferences (section 5.5), now in their fifth iteration.

A critical component of the MOBIlearn project, according to Vavoula, Sharples, O'Malley, and Taylor (2004) is completion of a reflective diary, in which learners record all learning episodes, whether mobile or not, experienced during their day. Participants are required to reflect upon their

- *Temporal context*: the date; the time span during the day when the learning took place; and its duration;
- *Social context*: the other people who were involved in the episode and the roles they assumed;
- *Situational context*: the location and event during which the learning episode took place;
- *Educational context*: any learning method that was employed; the forms of assessment applied; the purpose, if there was an explicit purpose; what was learned in relation to what it was originally intended should be learned; and the area in life to which this episode relates (work, hobbies, community work);
- *Activity context*: the learning topic; the kind of support that was available in terms of help from other people, printed or online manuals and other resources; the different activities that were performed; the different resources that were used; the problems that arose before, during or after the episode; and any greater learning project that this particular episode related to ;
- *Historical context*: other activities, not directly related to the learning, that were performed just before, during and immediately after the learning episode, to capture how learning interleaves with other, everyday activities. (p. 211)

Vavoula, Lefrere, O'Malley, Sharples, and Taylor (2004) have also contributed to the project in producing suggested guidelines for learning, teaching, and tutoring

in the mobile environment. Frohberg (2004) has documented the MBA case-study strand of the project, and Mellow (2005) has also reflected on its success.

5.6.2. M-Learning: http://www.m-learning.org/index.shtml

Introduced by Attewell and Webster (2004), the m-learning project is a three-year pan-European collaborative research and development initiative supported by the European Union. Through the employment of mobile technologies, the project seeks to enhance the literacy and numeracy learning experiences of young adults (aged 16-24) who have disengaged from full-time education. Embracing two university-based research units, two commercial companies, and an independent not-for-profit national educational R&D agency in Italy, Sweden, and the United Kingdom, the project has been established to investigate three overarching research questions:

- Can the enthusiasm of many young adults for mobile phones and other portable communications and entertainment devices be harnessed to encourage those not currently engaged in education or training to take part in learning experiences?
- Can m-learning result in improved literacy or numeracy skills or in changes in attitude or behaviour, including greater enthusiasm for learning and/or progression to further learning?
- What kind of pedagogical support and scaffolding do m-learners need? How can this be provided? (Attewell & Webster, 2004, p. 16)

The project's development of prototype products and innovative approaches has been guided by the following propositions:

- The fact that many young adults have poor literacy and numeracy skills (Moser 1999) and little or no interest in education and training (DfEE 2001) is both a personal tragedy and a waste of potentially valuable national and European resources.
- Learning is a natural human activity that most people will engage in if given the right encouragement. Many young people tend to be excited by, and interested in, new technologies.
- Learning mediated by technology can provide a convenient, personalised and non-judgemental alternative to traditional education. (Attewell & Webster, 2004, p. 15)

The second phase of the project was illustrated by Attewell and Savill-Smith in 2003, as represented in Figure 17. Now that the project has progressed past this point, key findings indicate that mobile learning:

- allows truly anywhere, anytime, personalised learning;
- can be used to enliven, or add variety to, conventional lessons or courses;
- can be used to remove some of the formality which non-traditional learners may find unattractive or frightening and can make learning fun;
- can help deliver and support literacy, numeracy and language learning;
- can help learners and teachers to recognise and build on existing basic literacy skills which allow young people to communicate in notational form via text messages;
- facilitates both individual and collaborative learning experiences;
- enables discrete learning in the sensitive area of literacy;
- can help to combat resistance to the use of ICT by providing a bridge between mobile phone literacy and PC literacy;
- has been observed to help young disconnected learners to remain more focused for longer periods;

- can help to raise self-confidence and self-esteem by recognising uncelebrated skills, enabling non-threatening, personalised learning experiences and enabling peer-to-peer learning and support. (Attewell, 2005, p. 2)

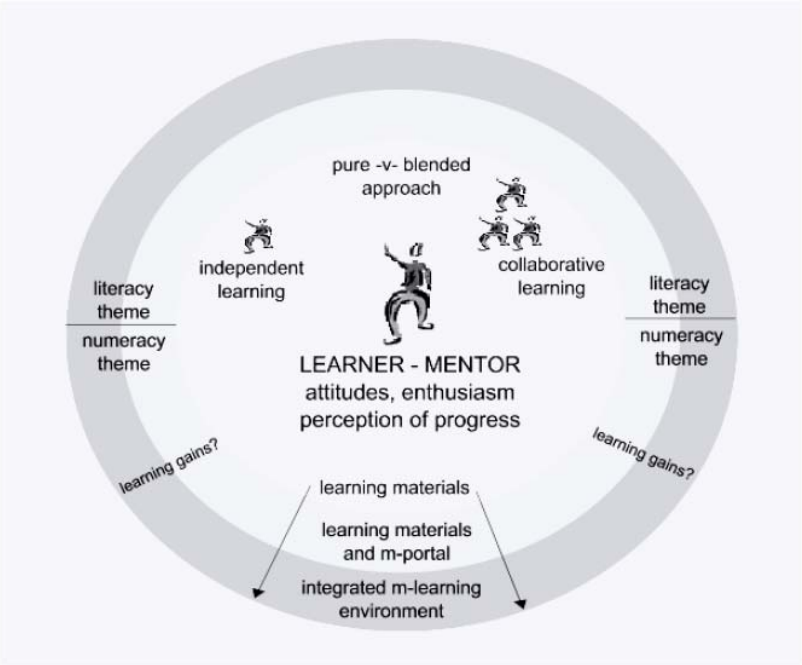

Figure 1 Inter-related aspects to the research activities of the m-learning project in phase 2

Figure 17: Interrelated aspects to the research activities of the m-learning project in phase 2 (Attewell & Savill-Smith, 2003, p. 9, Figure 1)

5.6.3. From e-learning to m-learning: http://learning.ericsson.net/mlearning2/project_one/index.html

'Specifically and practically, this project will map the evolution from the wired virtual learning environment of today, to the wireless learning environment of tomorrow.' (http://learning.ericsson.net/mlearning2/project_one/project.html)

Under the auspices of the European Union, the e-learning to m-learning project establishes the first stage in the creation of the global provision of training on the wireless Internet, promoting and reinforcing the contribution to be made by vocational training. It seeks to move from distance learning (d-learning) and electronic learning (e-learning) to mobile learning (m-learning). The project will trial and evaluate the didactic dimensions of three mobile technologies.

Chapter Four of the project's documentation (available at http://learning.ericsson.net/mlearning2/project_one/thebook/chapter4.html, 19/01/2006) details several m-learning initiatives. Several secondary projects can be considered to provide unique insight into the implementation of mobile learning.

5.6.4. GIPSY/Manolo: http://130.37.78.10/Projecten/Manolo/project/

Wentzel, van Lammeren, Molendijk, de Bruin, and Wagtendonk (2005) describe both the GIPSY project and its successor, the Manolo project, undertaken by SURF. GIPSY (Geo-Information for Integrating Personal Learning Environments) was developed to investigate a more flexible and location-based way of learning, with a primary objective to explore the wireless-supported learning environment.

GIPSY concluded in December 2003, having examined two courses in which students used wireless devices.

The Manolo project, the subsequent initiative, has focussed on the integration of electronic (e-), wireless (w-), and mobile (m-) learning in 2004 and 2005. The project's main goals have been to:

- Increase the fit between education type and goal, and the digital environment used to support it, with a view of offering a portfolio of e-, w-, and m-learning courses;
- Formalize this knowledge into educational, technological, and organizational blueprints and best practices; and
- Use the digital media, and especially w- and m-learning, to facilitate communication and community building in digital learning. (p. 13)

The Manolo project has sought to answer the following questions:

- What educational components will receive the largest growth or benefit from w- and m-learning, and what educational activities are most suitable or unsuitable for certain digital environments?
- Which courses and students would benefit most from this?
- Concerning the known issues in community building and communication for e-learning, what type of communication between students and teachers and among students can be improved or introduced, and what benefits are they supposed to bring?
- How do the educators' and tutors' roles change when we introduce these communication channels?
- How will w- and m-learning impact the education portfolio universities offer?
- What ICT infrastructure provides the most suitable environment for w- and m-learning?
- What support organizations will be needed to provide the necessary level of support to w- and m-learning deployment?
- What is the business model for universities and educational organizations that introduce w- and m-learning? What are the financial implications for organizations and students? What are the implications for the facilities (such as classrooms, meeting rooms, and computer rooms) of institutions that introduce w- and m-learning? (p. 13)

5.6.5. CAERUS: http://www.caerus.bham.ac.uk/

In an attempt to develop a complete context-aware educational resource system, the CAERUS project supports personalised learning opportunities for outdoor tourist sites and educational centres. Based at the University of Birmingham, the project has developed a handheld delivery application for Pocket PC devices with GPS capability which connects to a desktop administration system, and encompasses the ability to add maps, define regions of interest, and add theme-based multimedia tours. The principal investigator of the CAERUS project is Laura Naismith.

5.6.6. HandLer: http://www.eee.bham.ac.uk/handler/default.asp

According to its Web site, the aim of the HandLeR project is to develop personal mobile technologies for learning, based on a deep understanding of how people learn in multiple contexts over their lifetimes. Project areas include interaction design and systems engineering for handheld learning devices, wearable learning technology, and support for knowledge sharing and conversation between mobile learners.

5.6.7. Skoool: Intel IT Innovation Centre Initiative: http://www.skoool.com/

Smyth (2004) details the progress of the skoool educational initiative, supported by the Intel IT Innovation Centre, whose primary strategy is to bring together learning content, interaction, and visualisation in a real-world application to develop knowledge in the learner: skoool strives to engage the learner, making learning content accessible through appropriate technologies (p. 177). Designed to demonstrate and drive the adoption of broadband for learning and teaching, the project is well established in Ireland, and has been introduced to the UK and Sweden. With the introduction of myskoool, high-quality courseware has been made available offline, where students use peer-to-peer (P2P) technology to download the application, and subsequently courseware, from either the skoool portal or the nearest hosting peer.

5.6.8. WELCOME: Wireless E-Learning and Communication Environment: http://www.e-sj.org/Journals/esj2_3_franz_holger_hans.pdf

Lehner and Nösekabel (2002) outline the primary components of the WELCOME (Wireless E-Learning and Communication Environment) project at the University of Regensburg. The project is based on the premise that mobile/electronic education should not attempt to replace traditional education with tutors and instructors, but support both student and teacher by providing services that facilitate teaching, learning, and education-related administrative tasks (p. 1). The planned system employs an integrative approach, combining a variety of devices (both mobile and non-mobile) via a variety of transmitting techniques (wired and wireless).

5.6.9. Australian Initiatives

Recent projects in the Australian context have been documented by Ragus, Meredith, Dacey, Richter, Paterson, and Hayes (2005), as presented at MLearn 2005. The authors have detailed the projects, as below (p. 2):

Mobile Learning: Hand Held Innovations in Flexible Learning
A National New Practices in Flexible Learning initiative, funded by the Australian Flexible Learning Framework and managed by the Institute of TAFE Tasmania.
The project examined the practical and cost effective application of handheld mobile technology (PDA) for the delivery of flexible learning in the workplace. Specialist applications were developed through a joint collaboration between the learning institution, industry, staff and the learners as well as key stakeholders from many industry sectors.

QTI m-Player: question and testing interoperability (QTI) player for mobile devices
Selected businesses and registered training organisations (RTOs) around Australia will be the first in the world to use mobile learning in a secure environment. It will allow the vocational education and training (VET) system to create assessing instruments for teachers and trainers to test students anywhere and anytime using mobile devices.

TAFENSW – New England Institute
Another National New Practices in Flexible Learning initiative, which explored three initiatives for Handhelds:

- self-induction offsite by visitors - safety requirements of building sites, via dial-up to a website

- training and assessment in calibration skills for chemical mixing using interaction with a website
- GPS for personal interpretation of points of interest at sites such as zoos and botanical gardens.

Access and General Education Centre, TAFE NSW are in research trials engaging clients with m-learning initiatives including an interactive Mobile Film Festival, emailSMS broadcast activities as well as Mo-blogging and Video-blogging for workplace assessment, general education and Indigenous culture and story telling.

Swan TAFE, Western Australia conducted research as a New Practices in Flexible Learning initiative, in conjunction with the Australian Flexible Learning Framework (AFLF) in 2004 in the 'TxtMe: Supporting Disengaged Youth Using Mobile Technologies' project explored the dimensions of SMS messaging in the retention of disengaged youth via a collaborative, networked learning environment.

In addition, details of the **ECU Advantage Project** have been presented by Pospisil and Millar (2005) at ASCILITE 2005. In this project, Edith Cowan University (ECU) has explored the implications of m-learning via a laptop trial on its campus, seeking to improve student learning outcomes in using mobile computing to enhance collaboration, flexibility, and information access (p. 555). The establishing pedagogical criteria for the project included:

- Supporting the use of notebook and wireless connectivity to empower students to achieve successful outcomes in an exciting and stimulating fashion;
- Developing students' confidence, knowledge and skills in the selection and application of technology appropriate to their field of scholarship;
- Improving students' use of online resources and information at ECU;
- Developing new teaching and learning models utilising mobile computing technologies. (p. 554)

The QUT-based evaluation team concluded that: 'Strong learning outcomes across a number of dimensions were achieved with the key enabling processes being access to learning resources, immediacy and enhancement of group processes.' (Towers & Hearn, 2005, cited in Pospisil & Millar, 2005)

Further information about projects can be found in Wood (2003), detailing Becta's initiatives as well as several prominent projects.

5.7. Definitions

A glossary of key terms, derived from the current literature on mobile learning and pedagogical practice, is provided in section 8.0 to assist the reader in the comprehension of this newly-defined digital domain. In addition, Appendix A provides a novel equation for the conception of mobile learning, as defined by Laouris and Eteokleous (2005).

6.0. CONCLUSIONS

> 'In the future, the success of learning and teaching with mobile technologies will be measured by how seamlessly it weaves itself into our daily lives, with the greatest success paradoxically occurring at the point where we don't recognise it as learning at all.'
> (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 36)

This literature review has presented a comprehensive overview of current considerations to the philosophy, practice, and research of mobile learning. As described, the discipline offers significant benefit to learners and teachers in tertiary institutions, as well as those engaged in K-12 education and vocational training. The provision of learning on wireless and mobile devices may well be considered the 'educational revolution *du jour*' (Wagner, 2005, p. 42); it will have enduring significance as technologies are ever-more embedded, ubiquitous, and networked, enabling learning which is increasingly situated, personal, collaborative, and lifelong (Naismith, Lonsdale, Vavoula & Sharples, 2004, p. 5).

As educators and learners are required develop 'new digital communication skills, new pedagogies, and new practices' (Wagner, 2005, p. 52), a book detailing these developments will be well received by an audience of academics, administrators, theorists, and the learners themselves in a moment of reflection on the tools and techniques they have recently come to adopt and adapt.

Critical success factors for any m-learning implementation are those of the achievement of interactivity, coordination, negotiation and communication, optimal organisation of material, and mobility, motivation and collaboration (Barker, Krull, & Mallinson, 2005, p. 8).

In terms of addressing technical infrastructure and associated administrative issues, a ten-point plan may be followed in relation to the implementation of mobile technologies for learning:

- Investigate a cost model for infrastructure, technology and services;
- Study the requirements of all those involved in the use of the technology (learners, teachers, content creators) to ensure it is usable and acceptable;
- Assess that the technology is suited to the learning task and examine advantages and disadvantages of each technology before making a decision on which one to use;
- Assign the necessary roles for initiating and thereafter supporting mobile learning;
- Develop procedures and strategies for the management of equipment when it is provided by the institution;
- Provide training and (ongoing) technical support to the teachers to enable them to use mobile technologies to enhance current and to enable new instructional activities;
- Consider the use of mobile technologies for student administration tasks;
- Consider the use of mobile technologies to support collaborative and group learning;
- Discover and adopt suitable applications that match the needs of your specific classroom and map directly to your curriculum needs;
- Ensure security and privacy for the end users. (O'Malley, Vavoula, Glew, Taylor, Sharples & Lefrere, 2003)

As with the presentation of Williams and Goldberg (2005), this document

> 'celebrates the renewed commitment to learners and learning and the possibilities that new and emerging ICTs are creating. Such technology-facilitated liberation of tertiary education and the opportunities it presents is exciting and on the way to transforming the learning landscapes. Particularly exciting is the increasingly sophisticated pedagogy these ICTs support – a pedagogy that is interactive, engaging, and capable of producing deep learning outcomes for a greatly expanded population of learners, locally, nationally and, increasingly, globally.' (p. 726)

6.1. RECOMMENDATIONS

Given the potential centrality of the text compiled by Kukulksa-Hulme and Traxler (2005) *Mobile Learning: A Handbook for Educators and Trainers*, it may be wise to await its arrival before writing to the intended authors of the proposed book.

6.2. AREAS TO BE ADDRESSED BY FUTURE RESEARCH

Potential areas of future research and development have been outlined by several authors. In considering the design of personal mobile technologies for life-long learning, Sharples (2000) enumerates several issues, including:

- Altering the role and appearance of the mentor for learners of different ages, contexts and abilities;
- How to match the system and interface to the learner's cognitive and social abilities;
- Management of a lifetime of learning resources, and the role of companies and institutions in providing services to support personal mobile learning;
- Design and standardisation of the interaction between learners, teachers and experts, mediated by a range of personal technologies;
- Adaptive communications, to make optimal use of available bandwidth given the location and needs of the learner;
- Distribution of learning resources across personal technologies and the integration of personal learning resources with web-based learning environments;
- Design of new hardware to support easy and unobtrusive capture of everyday events;
- Support for collaboration between mobile learners (for example to allow capture and sharing of knowledge about a distributed or long-lasting event). (p. 16)

Drawing on the findings of Soloway, Norris, Blumenfeld, Fishman and Marx (2001), Misfud (2003) raises the following questions:

- Does the transition from disruptive to 'non-disruptive' technology require familiarisation with the technology? Is 'letting go of some control' indicative of a change in the learning culture? Does the 'zone of conflict over control' have to disappear?
- Is the teacher who chooses to use handhelds in the classroom contributing to the flow of activities in the classroom and thus seeking to change the learning culture? (The use of handhelds in this project was not imposed by management.) (pp. 102-3)

In terms of technological progress, the Manolo project (Wentzel, van Lammeren, Molendijk, de Bruin & Wagtendonk, 2005) has presented the following observations to be addressed by future research:

- The technology infrastructure is not yet ready for truly mobile learning. Stability, device availability, and course support problems remain unresolved.
- Personalization is crucial but is not yet sufficiently implemented—not because personalization tools don't exist, but because many courses' monolithic nature makes tailoring educational material to personal preferences difficult.
- Mobile learning works only when its practical use during the course is unmistakable and logical.
- The impact on educators is large, but little guidance exists on how to achieve the best results for mobile learning.
- Clear relationships seem to exist between what constitutes good and bad use of mobile learning. These relationships are not fully spelled out in educational terms.
- Wireless and mobile learning impact logistics, resources, and costs. These impacts must be identified and modeled to provide guidance for future implementations.
- Communication—both teacher–student and student–student—seems to find new channels and opportunities within mobile learning. This positively affects community building but must be streamlined from both the ICT and educational sides.
- The course Web site should be accessible by mobile devices. QuickPlace had serious limitations in this respect (bandwidth, Java) and is therefore not suitable.
- Batteries pose serious limitations to PDAs' usefulness in fieldwork. An average usability of four hours is too short for a normal fieldwork workday.
- PDAs will do an excellent job as "fieldwork computers" in most cases, since in fieldwork weight and size are defining factors. (p. 17)

7.0. REFERENCES[1]

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-X-

-Y-

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8.0. GLOSSARY

-A-

Asynchronous Communication: 'Virtual learning occurs either in the form of asynchronous (not at the same time) or **synchronous** (immediate and face-to-face) communication between teachers and students or student to student. In the case of videoconferencing, communication occurs in synchronous fashion. In the case of online or Internet-based instruction, interaction occurs in a matter that is asynchronous – not simultaneous and not occurring real time. Examples of asynchronous communication include e-mail, e-mail lists, and bulletin boards.' (http://www.uen.org/delivery/ivc_glossary.shtml, 19/01/2006)

-B-

Blended Learning: 'Blended learning is the most logical and natural evolution of our learning agenda. It suggests an elegant solution to the challenges of tailoring learning and development to the needs of individuals. It represents an opportunity to integrate the innovative and technological advances offered by online learning with the interaction and participation offered in the best of traditional learning. It can be supported and enhanced by using the wisdom and one-to-one contact of personal coaches.' (Thorne, 2003, p. 16)

Blog: 'A public web site where users post informal journals of their thoughts, comments, and philosophies, updated frequently and normally reflecting the views of the blog's creator.' (http://www.worldwidelearn.com/elearning-essentials/elearning-glossary.htm, 19/01/2006)

'Blog, defined as "a Web site that contains an online personal journal with reflections, comments and often hyperlinks," was one of the most looked-up words on [Meriam Webster Inc.'s] Internet sites... Freed from the constraints that govern traditional print and broadcast news organizations, blogs spread gossip while also serving as an outlet for people increasingly disenchanted with mainstream media.' (Reuters, "'Blog' Tops U.S. Dictionary's Words of the Year," November 30, 2004)

Bloom's Taxonomy: 'Popular instructional model developed by the prominent educator Benjamin Bloom. It categorises thinking skills from the concrete to the abstract-knowledge, comprehension, application, analysis, synthesis, evaluation. The last three are considered higher-order skills.' (Wegerif, 2002, p. 37)

Bluetooth: 'An industrial specification for wireless personal area networks (*see* **PAN**) using radio frequencies to link enabled devices.' (Wagner, 2005, p. 46)

-C-

Chat: 'A form of **synchronous** online communication. A discussion between any number of logged-in users to have a typed, real-time, on-line conversation, either by all users logging into the same computer, or more commonly nowadays, via a network.' (http://alt.uno.edu/glossary.html, 19/01/2006)

Code Division Multiple Access (CDMA): 'A rival to the **TDMA** standard in the Americas, this standard was developed by QualComm, from which providers must license its use. CDMA carriers in the United States include Sprint PCS (which started as a **GSM** carrier), Alltel, and Verizon.' (Wagner, 2005, p. 46)

Collaborative Learning: 'The process of students working in teams to pursue knowledge and learning. In collaborative learning, information, ideas, and problem solving are actively shared among the team. […] Collaboration can also be asynchronous, where students log onto a network at different times and locations leaving their contributions for others to see and discuss.' (Pinheiro, 1998, pp. 118-9)

Computer-Based Training (CBT): 'Training conducted using a computer, often used when referring to education or training presented while a computer is not connected to a network.' (http://www.worldwidelearn.com/elearning-essentials/elearning-glossary.htm, 19/01/2006)

Computer Mediated Communication (CMC): 'CMC is an acronym used by many academic writers to refer to all situations where computers are used to facilitate human communication when using the Internet (Ellsworth, 1994). For the purposes of this study, the term e-communication is used to represent CMC. The e-communication tools examined in this study included the World Wide Web (WWW), Electronic Mail (e-mail), and electronic bulletin boards.' (Firmin, 2005, p. 215)

Constructivist Instructional Theory: 'A theory of learning which posits that learners construct an understanding of the world through the process of acquiring knowledge and reflecting on actual experiences. According to this theory, learning is an active and social process, not static accumulation of data and skills.' (http://www.uen.org/delivery/ivc_glossary.shtml, 19/01/2006)

Creative Thinking: 'Imaginative activity fashioned so as to produce outcomes that are both original and of value.' (NACCE, 1999)

Critical Thinking: 'Critical thinking is a term used to refer to those kinds of mental activity that are clear, precise, and purposeful. It is typically associated with solving complex real world problems, generating multiple (or creative) solutions to a problem, drawing inferences, synthesizing and integrating information, distinguishing between fact and opinion, or estimating potential outcomes, but it can also refer to the process of evaluating the quality of one's own thinking.' (http://www.senate.psu.edu/curriculum_resources/guide/glossary.html, 19/01/2006)

-D-

Digital Immigrant: A term coined by Marc Prensky (2001; 2004) to differentiate students who are familiar with technology, as **Digital Natives**, with their lecturers who retain an accent from the past, having been socialised differently from their children, and who do not fully adapt to and adopt new technologies. Digital Immigrants will refer to the Internet for information second, rather than first, and will learn how to use equipment from manuals, rather than natively.

Digital Native: A term coined by Marc Prensky (2001; 2004) to indicate that students in the twenty-first century are all "native speakers" of the digital language of computers, video games, and the Internet.
Prensky (2001) states:

> 'Our students have changed radically. Today's students are no longer the people our educational system was designed to teach. Today's students have not just changed incrementally from those of the past, nor simply changed their slang, clothes, body adornments, or styles, as has happened between generations previously. A really big discontinuity has taken place.

One might even call it a 'singularity' - an event which changes things so fundamentally that there is absolutely no going back. This so-called 'singularity' is the arrival and rapid dissemination of digital technology in the last decades of the 20th century.'

Discussion Forum: 'An Internet forum is a facility on the World Wide Web for holding discussions, or the web application software used to provide the facility. Web-based forums, which date from around 1995, perform a similar function as the dial-up bulletin boards and Internet newsgroups that were numerous in the 1980s and 1990s. A sense of virtual community often develops around forums that have regular users. Technology, computer games, and politics are popular areas for forum themes, but there are forums for a huge number of different topics. Internet forums are also commonly referred to as web forums, message boards, discussion boards, discussion forums, discussion groups, bulletin boards, fora (proper latin plural) or simply forums.' (http://en.wikipedia.org/wiki/Discussion_forum, 19/01/2006)

Disruptive Technology: 'The term "disruptive technology" has mainly been used in organisational theories. Christensen (1997) noted: "Disruptive technologies … are usually simpler and cheaper … offer less capability … they are usually shunned by well-managed companies – which are often later destroyed by [the disruptive technologies]."' (Misfud, 2003, p. 100)

Distance Learning: Distance education is a form of education characterised by:

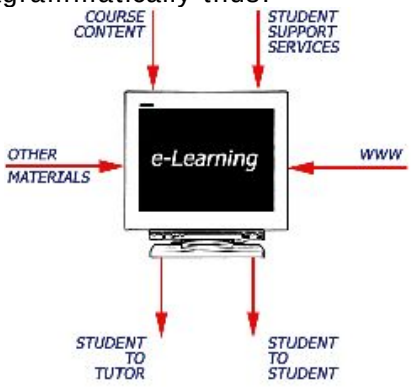
- 'The quasi-permanent separation of teacher and learner throughout the length of the learning process (this distinguishes it from conventional face-to-face education);
- The influence of an educational organisation both in the planning and preparation of learning materials and in the provision of student support services (this distinguishes it from private study and teach-yourself programmes);
- The use of technical media - print, audio, video or computer, or the world wide web, to unite teacher and learner and carry the content of the course;
- The provision of two-way communication so that the student may benefit from or even initiate dialogue (this distinguishes it from other uses of technology in education); and
- The quasi-permanent absence of the learning group through-out the length of the learning process so that people are usually taught as individuals rather than in groups, with the possibility of meetings, either face-to-face or by electronic means, for both didactic and socialisation purposes.' (Keegan, 1996, p. 50)

-E-

802.11: 'The official designation for the wireless protocol known as **Wi-Fi**. Short for "wireless fidelity," Wi-Fi denotes a set of wireless LAN standards developed by working group 11 of the IEEE LAN/MAN Standards Committee (IEEE 802). The term is also used to refer to the original 802.11, which is now sometimes called "802.11legacy." The 802.11 family currently includes six over-the-air standards that all use the same wireless internet protocol. 802.11b was the first widely accepted wireless networking standard, followed by 802.11a and 802.11g.' (Wagner, 2005, p. 46)

e-Learning: 'e-Learning represents the awarding of nationally and internationally recognised university degrees, college diplomas or training certificates to students

who spend all or some of their study period in front of computer screens. It might be represented diagrammatically thus:



'In this diagram the computer screen represents the study area - the equivalent of the lecture theatre or classroom or practical training session of conventional education, or the student's home in distance education.
In the diagram course content is provided on the computer screen and student support services are provided electronically to the student in the form of electronic communication or feedback on assignments or other questioning. Access to the WWW is provided for other resources, suggested readings and library resources. Other materials can be CD-ROMs, floppy discs, or audio, video or paper-based resources.
In the diagram student to student communication is by emails, bulletin boards or chat rooms in which students can communicate with other students in their class or institution mainly by typed interactions. Student to tutor communication is also mainly by email, with tutor intervention in listservs a further possibility and tutor reaction to student assignments, quizzes and other forms of summative or formative evaluation.' (Keegan, 2002)

Emerging Technologies: Electronic tools and systems new to the field that have not yet been integrated or standardised.

-F-

F2F (Face-to-Face): This term is used to describe a traditional classroom environment, as compared to the virtual.

4G: 'Fourth-generation mobile telephone technology. When implemented, 4G will be the successor to **3G.** It will feature high-speed mobile wireless access with a very high data transmission speed, of the same order of magnitude as a local area network connection (10 Mbits/s and up). It also addresses the notion of pervasive networks, an entirely hypothetical concept in which the user can be simultaneously connected to several wireless access technologies and can seamlessly move between them.' (Wagner, 2005, p. 46)

-G-

General Packet Radio Service (GPRS): 'A mobile data service available to users of **GSM** mobile phones. It is often described as "2.5G"—that is, a technology between the second generation (**2G**) and third generation (**3G**) of mobile telephony. It provides moderate speed data transfer, high-speed "always on" data connections that are much faster than the traditional 9600 bps, by using unused **TDMA** channels in the **GSM** network.' (Wagner, 2005, p. 46)

Generation C: 'The Generation C phenomenon captures the an avalanche of consumer generated "content" that is building on the Web, adding tera-peta bytes of new text, images, audio and video on an ongoing basis. The two main drivers fuelling this trend? (1) The creative urges each consumer undeniably possesses. We're all artists, but until now we neither had the guts nor the means to go all out. (2) The manufacturers of content-creating tools, who relentlessly push us to unleash that creativity, using -- of course -- their ever cheaper, ever more powerful gadgets and gizmos. Instead of asking consumers to watch, to listen, to play, to passively consume, the race is on to get them to create, to produce, and to participate.' (Trendwatching.com, 2005)

Global Positioning System (GPS): 'A satellite navigation system used for determining one's precise location and providing a highly accurate time reference almost anywhere on earth. GPS is controlled by the U.S. Department of Defense and can be used by anyone, free of charge.' (Wagner, 2005, p. 46)

Global System for Mobile-telephones (GSM): 'The most commonly used cell phone standard in the world. GSM systems are used in nearly two hundred countries, with six hundred million subscribers worldwide. It originated in Europe and can now be found in Africa, Asia, Australia, and North America. Originally utilizing the 900 Mhz spectrum, GSM providers in parts of Europe, Africa, and Asia later added additional capacity at 1800 Mhz. In North America, GSM service is currently available only at 1900 Mhz. Most cell phone manufacturers offer dual-band (900 and 1900 Mhz) or tri-band (900, 1800, and 1900 Mhz) phones that will work in most places GSM systems are found.' (Wagner, 2005, p. 46)

-H-

-I-

Infusion: 'Integrating thinking skills instruction into the regular curriculum; infused programs are commonly contrasted to separate programs, which teach thinking skills as a curriculum in itself.' (Wegerif, 2002, p. 37)

Instant messaging (IM): 'A client that hooks up a user to an instant messaging service. Instant messaging differs from e-mail in that conversations happen in real time. Most services offer a "presence awareness" feature, indicating whether people on one's list of contacts are currently online and available to chat. Generally, both parties in the conversation see each line of text right after it is typed (line by line), thus making it more like a telephone conversation than exchanging letters.' (Wagner, 2005, p. 46)

Interactive Videoconferencing (IVC): 'Two-way video and audio communication supported by a computer network or digital phone line that facilitates interaction between people in two (point-to-point) or more (multipoint) locations, creating a virtual classroom or conference room.' (http://www.uen.org/delivery/ivc_glossary.shtml, 19/01/2006)

-L-

Learning Management System (LMS): The definition of a Learning Management System (LMS), also known as Course Management System, Managed Learning Environment, or Virtual Learning Environment, has been provided by Paulsen (2003):

> 'Learning Management System is a broad term that is used for a wide range of systems that organize and provide access to online learning services for students, teachers, and administrators. These services usually

include access control, provision of learning content, communication tools, and administration of user groups. Another term that often is used as a synonym for LMS is learning platform.'

Learning Object: 'Discrete elements of learning content that meet a defined learning objective, and are possibly independently assessable, which may take the form of text, graphics, video, stills, animations, diagrams or audio.' (Rodin, 2004, p. 171)

Learning Portal: 'Any Website that offers learners or organizations consolidated access to learning and training resources from multiple sources. Operators of learning portals are also called content aggregators, distributors, or hosts.' (www.cybermediacreations.com/elearning/glossary.htm, 19/01/2006)

-M-

MP3: 'An audio compression format capable of a great reduction in the amount of data required to reproduce audio while sounding like a faithful reproduction of the original uncompressed audio to most listeners.' (Wagner, 2005, p. 47)

Metacognition: 'The process of planning, assessing, and monitoring one's own thinking.' (Wegerif, 2002, p. 37)

Mobile Learning: Mobile learning has been variously defined, such as Nyíri's (2002) conception of the concept as "learning that arises in the course of person-to-person mobile communication." In the work of Laouris and Eteokleous (2005), the authors put forward the thesis that not only should educators not constrain the definition of mobile learning to *learning through mobiles*, they must shift focus from device to human:

> 'We suggest taking a broader view that accounts for a learner freely moving in his physical (and virtual) environment. Tomorrow's learners will have access to a dynamically changing repertoire of devices and services that will differ in speed, processing power, monitor (and other output) characteristics, etc. As our engagement with technology changes with time, mobile learning becomes a function not only of time, but also of the momentarily available and dynamically changing technology. The various mobile devices, embedded in our virtual environment, need to be considered not only in concert and in context with their inter-relationships and interdependencies to different types of content and content delivery. They must also be considered as functions to time-varying levels of attention, interest, preferences and motivation of the learner. The momentary access to the learner's private learning environment (which is constrained by the mobile device at hand) imposes requirements as to what type of learning might be advisable, possible or appropriate. We thus deduct that a socially and educationally responsible definition must view the learner as the one being mobile and not his/her devices! What needs to move with the learner is not the device, but his/her whole learning environment.' (pp. 6-7)

See also Appendix A.

Multimedia Messaging System (MMS): 'The successor to **SMS,** this enables subscribers to compose and send messages with one or more multimedia (digital photos, audio, video) parts. Mobile phones with built-in or attached cameras, or with built-in **MP3** players, are very likely to also have an MMS messaging client—a software program that interacts with the mobile subscriber to compose, address, send, receive, and view MMS messages.' (Wagner, 2005, p. 47)

-N-

Net Generation: Diane Oblinger expresses the key traits of today's 'net generation' as being: digitally literate; always on; mobile; experimental; and community-oriented. (Oblinger, 2004, 2005)

-O-

Opera: 'A cross-platform Internet software suite consisting of a Web browser, e-mail/news client, address book, news-feed reader, IRC chat client, and download manager. Its core layout engine is licensed by business partners Macromedia for previewing Web pages and Dreamweaver. Opera has gained a leading role in browsers for smartphones and PDAs with its Small Screen Rendering technology.' (Wagner, 2005, p. 47)

-P-

Participatory Design: 'Participatory design is an approach to design that attempts to actively involve the end users in the design process to help ensure that the product designed meets their needs and is usable.' (http://en.wikipedia.org/wiki/Participatory_design, 19/01/2006)

Personal Area Network (**PAN**): 'A network for communication among computer devices (including telephones and personal digital assistants) close to one person, where the devices may or may not belong to the person in question. The reach of a PAN is typically a few meters. PANs can be used for communication among the personal devices themselves (intrapersonal communication) or for connecting to a higher-level network and the Internet.' (Wagner, 2005, p. 47)

Personal Digital Cellular (PDC): 'Behind **GSM** and D-AMPS, the world's mostly widely used digital system. Its use is limited to Japan.' (Wagner, 2005, p. 47)

Personal Handyphone System (PHS): 'A newer Japanese standard especially designed for high-speed data transmission up to 32 Kbps. Some installations may also be found in parts of China, Thailand, and Taiwan.' (Wagner, 2005, p. 47)

Personal Technology: 'The concept of personal technologies, coined by Sharples (2000), where mobile technology and other internet technologies are defined as subsets of technology used in private and public situations, provides a promising approach. This concept helps to illuminate both the structures of interaction and the relations between technologies and the situations in which they are used.' (Danielsson, Hedestig, Juslin & Orre, 2003, p. 47)

Pervasive Learning: 'Learning that uses technology that is omnipresent (pervasive) in a learner's everyday life. The easiest way to consider pervasive learning is to think of it spatially: pervasive learning is not isolated to a single geographic location such as a classroom; instead, it happens anywhere at any time. Technology commonly associated with pervasive computing includes handheld computers, mobile phones, smart cards, sensors, GPS, Galileo, etc. — i.e. anything that allows a user to access and exchange information while on the move — but pervasive learning does not need to be restricted to the use of mobile or location-based technologies. The idea of pervasive learning is to create a network of devices, people, and situations that allow complex learning experiences to play out.' (Thomas, 2005, p. 1)

Podcast: 'Podcasting, a portmanteau of Apple's "iPod" and "broadcasting", is a method of publishing files to the Internet, allowing users to subscribe to a feed

and receive new files automatically by subscription, usually at no cost. It first became popular in late 2004, used largely for audio files.' (http://en.wikipedia.org/wiki/Podcast, 19/01/2006)

-Q-

-R-

Radio Frequency Identification (**RFID**): 'A method of remotely storing and retrieving data. An RFID tag is a small object, such as an adhesive sticker that can be attached to or incorporated into a product. RFID tags contain antennas to enable them to receive and respond to radio-frequency queries from an RFID transceiver.' (Wagner, 2005, p. 47)

-S-

SCORM (Shareable Content Object Reference Model): 'The Sharable Content Object Reference Model (SCORM) is a collection of specifications that enable interoperability, accessibility and reusability of web-based learning content.' (http://www.egov.hyperwave.com/solutions/standards.html, 19/01/2006)

Short Message Service (**SMS**): 'Available on most digital mobile phones, a service that permits the sending of short messages (also known as SMSes, text messages, messages, or simply texts or even txts) between mobile phones and other handheld devices. SMS was originally designed as part of the **GSM** digital mobile phone standard but is now available on a wide range of networks, including **3G** networks.' (Wagner, 2005, p. 47)

Situated Learning: 'Lave argues that learning, as it normally occurs, is a function of the activity, context, and culture in which it occurs (i.e., it is situated). This contrasts with most classroom learning activities which involve knowledge which is abstract and out of context. Social interaction is a critical component of situated learning – learners become involved in a "community of practice" which embodies certain beliefs and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its center, they become more active and engaged within the culture and hence assume the role of expert or old-timer. Furthermore, situated learning is usually unintentional rather than deliberate. These ideas are what Lave & Wenger (1991) call the process of "legitimate peripheral participation."' (http://tip.psychology.org/lave.html, 19/01/2006).

Smartphone: 'Any handheld device that integrates personal information management and mobile phone capabilities in the same device. Often, this includes adding phone functions to already capable PDAs or putting "smart" capabilities, such as PDA functions, into a mobile phone. The key feature of a smartphone is that one can install additional applications to the device. Features tend to include Internet access, e-mail access, scheduling software, built-in camera, contact management, and occasionally the ability to read files in a variety of formats including Macromedia Flash and Microsoft Office applications.' (Wagner, 2005, p. 47)

Symbian: 'An operating system for smart phones. In an August 2004 report by In-Stat/MDR, Symbian-based smartphones were predicted to dominate over the next five years. Microsoft's CE platform is predicted to be second by 2006.' (Wagner, 2005, p. 47)

Synchronous Communication: 'Computer-mediated exchanges of messages when the participants are online simultaneously. These exchanges occur in "real-time".' (http://www.gc.maricopa.edu/kschwalm/ccguide/defs.html, 19/01/2006)

-T-

2G: 'Second-generation mobile telephone technology. 2G cannot normally transfer data, such as e-mail or software, other than the digital voice call itself and other basic data such as time and date, although **SMS** messaging is available for data transmission for some standards. 2G services are frequently referred as Personal Communications Service (PCS) in the United States. 2G technologies are either **TDMA**-based or **CDMA**-based standards, depending on the type of multiplexing used for signal exchange.' (Wagner, 2005, p. 47)

2.5G: *See* **General Packet Radio Service (GPRS).**

3G: 'Third-generation mobile telephone technology. The services associated with 3G provide the ability to transfer both voice data (such as making a telephone call) and non-voice data (such as downloading information, exchanging e-mail, and **instant messaging**).' (Wagner, 2005, p. 47)

Thinking skills: 'Thinking skills' and related terms are used to indicate a desire to teach processes of thinking and learning that can be used in a wide range of real-life contexts. The list of thinking skills in the English National Curriculum is similar to many such lists: information-processing, reasoning, enquiry, creative thinking and evaluation.

Transfer: 'Taking something, an idea or skill, that has been learnt in one context and applying it in a different context.' (Wegerif, 2002, p. 37)

Transparent Technology: 'In an online course, technology is said to be transparent (or seamless) when it is easy to use, intuitive in nature, and is NOT the focus of the learning experience. If programs are difficult to use and the system has frequent breakdowns, the technology is not seamless and hinders the learning process. Technology should merely be a means to deliver course content, facilitating the learning process.' (http://www.coloradomtn.edu/distlearn/resources/glossary.html, 19/01/2006)

-U-

Ubiquitous Computing: 'Ubiquitous computing (ubicomp, or sometimes ubiqcomp) integrates computation into the environment, rather than having computers which are distinct objects. Other terms for ubiquitous computing are pervasive computing, calm technology, and things that think. Promoters of this idea hope that embedding computation into the environment and everyday objects would enable people to move around and interact with information and computing more naturally and casually than they currently do. One of the goals of ubiquitous computing is to enable devices to sense changes in their environment and to automatically adapt and act based on these changes based on user needs and preferences.' (http://en.wikipedia.org/wiki/Ubiquitous_computing, 19/01/2006)

-V-

Virtual Field Trip: 'A simulated, real-time field trip. In the case of videoconferencing, students interact in a live event with a remotely located field trip host.' (http://www.uen.org/delivery/ivc_glossary.shtml, 19/01/2006)

Virtual Student: 'A learner who, through electronic means, accesses courseware and instruction, learns concepts and content, asks questions of a remote teacher, and sends the remote teacher work for assessment purposes.' (http://www.uen.org/delivery/ivc_glossary.shtml, 19/01/2006)

-W-

Web-Based Training (WBT): 'Training which is delivered over a network (LAN, WAN or Internet). Can be either Instructor-led or Computer Based. Very similar to e-Learning, but it implies that the learning is in the professional or corporate level.' (http://www.directdegree.com/s/DistanceEducationGlossary.shtml, 19/01/2006)

Webcasting: 'The delivery of live or delayed sound or video broadcasts using web technologies. The sound or video is captured by conventional video or audio systems. It is then digitised and streamed on a web server.' (http://www.liv.ac.uk/webteam/glossary/, 19/01/2006)

WiFi: *See* 802.11.

Wireless Communication: 'Communication that takes place via airwaves as opposed to cables or telephone lines. It [was] estimated that by 2003 nearly 62 million people [were to] use wireless devices (such as cell phones or PDAs) to access the Internet, an increase of about 728% since 2000.' (http://www.communication.gc.ca/glossary.html, 19/01/2006)

Worldwide Interoperability for Microwave Access (WiMAX): 'The domain of working group number 16 of the IEEE 802 (IEEE 802.16) that specializes in point-to-multipoint broadband wireless access. Predictions suggest that WiMAX will take over the **3G** networks and become the **4G** wireless technology.' (Wagner, 2005, p. 47)

9.0. VERSION CONTROL

Version No.	Issue Date	Nature of Amendment	Author	Editor/s
0.1	10/02/2006	References repair	Rachel Cobcroft	
0.2	28/02/2006	Insertion of references; glossary; appendices	Rachel Cobcroft	

APPENDIX A: DEFINING MOBILE LEARNING AS A FUNCTION OF ITS FACETS

Source: Louris & Eteokleous (2005, pp. 8-10)

Defining mobile learning as a function of its facets

From the analysis of the proceeding sections, it becomes obvious that a systematically correct and systemically complete definition of mobile learning must take into account many parameters and also ways in which they interact and influence each other. In order to be able to visualize, conceptualize, and hopefully later, study in greater detail such parameters and their inter-relations, we propose the following abstract formulation for the definition.

$$(1) \qquad \text{MLearn} = f\{\, t, s, LE, c, IT, MM, m \,\}$$

t = time	Whereas t was discontinuous and discrete for previous paradigms of learning (e.g. mainly whenever in classroom), for m-learning time during which mobile learning can take place may be continuous.
s = space	In the classroom paradigm, space was simply defined as the classroom and to some extend the learners' home. Now space is not constrained at all and it may even incorporate virtual spaces.
LE = l-environm	The learning environemnt consists of at least those elements summarized in Table 5.
c = content	The curriculum, the specific educational themes and chosen topics covered are now structured in a completely different fashion and follow different rules and priorities. The learner usually shifts from topic to topic and from discipline to discipline, in what might appear as a chaotic pattern.
IT = technology	This parameter is quite complex. It encompasses all technological aspects and momentary characteristics of both the hand-held device and the surrounding environment (i.e., services available, antennas, repeaters, external devices within reach etc.).
MM = mental	This parameter contains as a conglomerate of the learner's mental abilities, prior knowledge, preferences, motivation, momentary attention etc.
m = method	The "method" is a conglomerate of all parameters related to delivery of and interaction with content. These may include pedagogy, philosophy as well as technical and logistical aspects such as method of presentation (or assessment).

(2) $s = f\{\, MM \,\}$ The spaces which the learner may wish to visit or wander (theoretically) depend on his/her free will and preferences, and to some extent to time (i.e., during the night, mobile learning activities might not be possible).

(3) $c = f\{MM, soc, edu\}$

- edu = educationally relevant
- soc = socially responsible

The chosen educational themes must be the result of a *negotiation* between the learner's agent (in which his/her MM is coded) and what we as society wisely have decided that it is socially responsible.

(4) $LE = f\{\, IT, S, C \,\}$

- S = available services (agents, facilitators, access to knowledge)
- C = learning community

The learning environment is not only defined by the available technology but also by the presence of and access to available services such as agents, facilitators/coach, knowledge bases, tracking ssytems as well as other learners who are part of a learning community.

(5.1) $IT = f\{s\}$ The IT available depends on the technologies that are available in the concrete space (physical or virtual in which the learner is working.

(5.2) $IT = f\{s, m\}$ We propose IT to also be a function of m; this imposes new requirements for design because it implies that if the interaction with a specific type of knowledge requires some m that is currently not available, IT must be in a position to ubiquitously negotiate the addition of the necessary service.

(6) $MM = f\{MA, k, p, \alpha\}$

- MA = mental attributes
- k = prior knowledge
- p = preferences
- α = attention

We suggest that m is a function of the learner's mental abilities, prior knowledge, preferences, motivation, momentary attention etc. This imposes new requirements for the design of educational environments and choice of pedagogy, because it requires knowledge of these parameters. The authors have a parallel project in which they attempt to model MA. Parameter k, can theoretically be available (in the future) if we assume that all learning activities of the individual are negotiated by his/her (permanently available and accessible) agent. Parameter p can be dynamically modified by the learner. The inclusion of the parameter α opens up a whole new area for research, because it will require real-time methods of monitoring and keeping track of the learner's changing attention.

(7) $m = f\{PM, Ph\}$

- PM = Pedagogical Model
- Ph = Philosophical paradigm

The choice of the methods to be applied during the learning interactions is a function of a pedagogical model (or sub-unit of it) appropriate for the type of learning experiences at hand, as well as a philosophical approach suited for the particular moment (i.e., location, learner's preferences, etc.). Research in the design, standardization, delivery, etc. of learning objects, as well as research related to modeling and managing user preferences, is of great importance for the concretization of these relations.

This is probably the first attempt to develop a model of mobile learning that inspires to include the full spectrum of actors in both a systematically correct and systemically complete way. As such it probably contains inaccuracies and inconsistencies. The author will be thankful to contributions and criticism. The original ideas for this approach stem from the KnowledgePacket® concept which the authors have applied while developing in the early 1990's, a 6-year long curriculum (referred to as Cyber Kids Method) used in the Cyber Kids experiment to introduce IT in the lives of young children (see Laouris 2005 paper presented in the same conference).

APPENDIX B: EXISTING BOOKS ON MOBILE LEARNING

The following pages provide bibliographic information about recent and soon-to-be published books on mobile learning. Details have been sourced from Amazon.com and the QUT library catalogue. Books with chapters or sections relevant to mobile learning are also listed, with the relevant section highlighted. References include conference proceedings which have been published in book format. One suspects that the publisher will not consider these.

The most significant contribution to the field appears to be *Mobile Learning: A Handbook for Educators and Trainers (The Open and Flexible Learning Series)* edited by Agnes Kukulska-Hulme and John Traxler (2005). To what extent this is a 'how-to' handbook remains to be seen.

The only other book to which I have had exposure is *Advanced web-based training strategies: unlocking instructionally sound online learning* written by Margaret Driscoll and Saul Carliner (2005). Chapter 8 considers mobile learning, in which the authors:

- Define m-learning and explains (*sic*) why it is considered a delivery strategy – not a learning strategy;
- Differentiate among fixed line, m-learning, wireless learning, and disconnected use delivery strategies;
- Explain what is fuelling the growth of m-learning;
- Describe the benefits and limitations of m-learning;
- Describe three approaches to m-learning;
- Consider the other educational tasks that mobile and wireless devices are being used to accomplish;
- Provide a portfolio of examples of m-learning. (p. 207)

The chapter contents are broken down as follows:

- What is m-learning?
- Why should you use wireless and mobile learning?
- Benefits and limitations of mobile learning
- A portfolio of m-learning strategies
- Guidelines for wireless and mobile learning
- In practice: Chris von Koschembahr: IBM's worldwide mobile learning leader
- Conclusion
- Reflection and application

The Driscoll and Carliner (2005) textbook chapter provides a basic introduction. As the jacket details:

> Balancing educational theory with the practical realities of implementation, Driscoll and Carliner outline the benefits and limitations of each strategy, discuss the issues surrounding the implementation of these strategies, and illustrate each strategy with short scenarios drawn from real-world online learning programs representing a wide variety of fields including technology, financial services, health care, and government.

Amazon ref:
http://www.amazon.com/gp/product/0415357403/sr=8-1/qid=1140496737/ref=pd_bbs_1/002-2832778-0157626?%5Fencoding=UTF8

Mobile Learning: A Handbook for Educators and Trainers (The Open and Flexible Learning Series) (Paperback)
by Agnes Kukulska-Hulme (Editor), John Traxler (Editor)

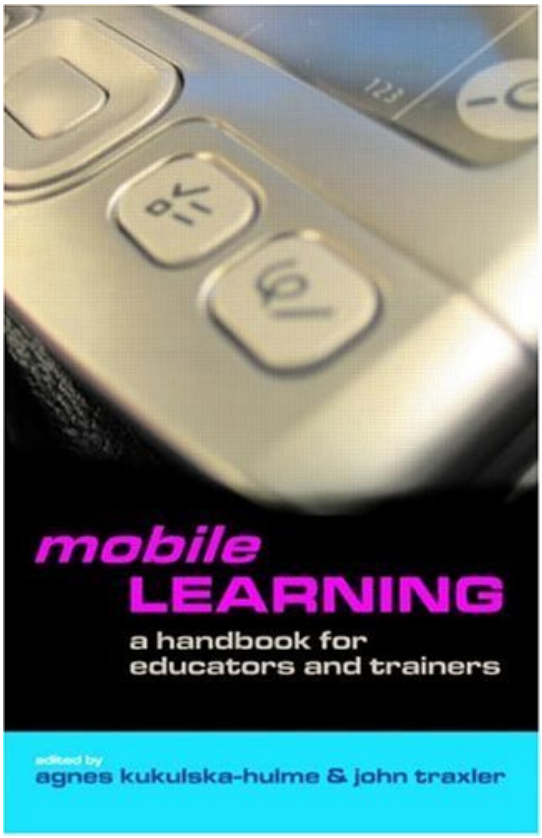
Book Description

This book is a timely introduction to the emerging field of mobile learning, explaining the technologies involved, their applications and the multiple effects on pedagogical and social practice. Mobile devices include handheld computers, smartphones and PDAs, and this book will emphasise the issues of usability, accessibility, evaluation and effectiveness, drawing from case studies written by researchers and practitioners.

This is a cutting-edge subject in open and flexible learning, yet in spite of being the subject of a number of e-learning conferences, very little has been published on it (see competition analysis). This book will be the first to hit the market and will be picked up primarily by HE and FE readerships, but also by trainers wanting to find out about the opportunities offered by these new technologies.

About the Author
Agnes Kukulska-Hulme is a Senior Lecturer in Educational Technology in the Open University's Institute of Educational Technology, UK.

John Traxler is Research Fellow in the Centre for Learning and Teaching and e-Innovations Centre at the University of Wolverhampton, UK.



Amazon ref:
http://www.amazon.com/gp/product/9518266905/sr=8-11/qid=1140496737/ref=sr_1_11/002-2832778-0157626?%5Fencoding=UTF8

Professional Mobile Learning (Paperback)
by KYNASLAHTI

Editorial Reviews

Book Description

Mobile learning is often mentioned, rarely carefully analyzed, hardly ever defined or theorized. Evidently, people are increasingly using mobile technology to carry out their doings, and more and more of these doings are of educational nature. This book takes a step towards a better understanding of mobile learning as both the everyday practice of learners and teachers and as a technology-based educational phenomenon calling for theoretical elaboration. The international cast of authors comes from a variety of disciplines, each of which sheds a specific light on mobility. The book includes reports of pilot projects from different educational branches. The theory of mobility is discussed based mostly in education, computer science and social sciences. The book is aimed for those interested in the use of mobile technology in the field of education, including students, adult learners and teachers as well as researchers of different disciplines. It also provides a viewpoint for those working in telecommunication or educational services. Computer scientists specializing in mobile technology may also find the book useful.

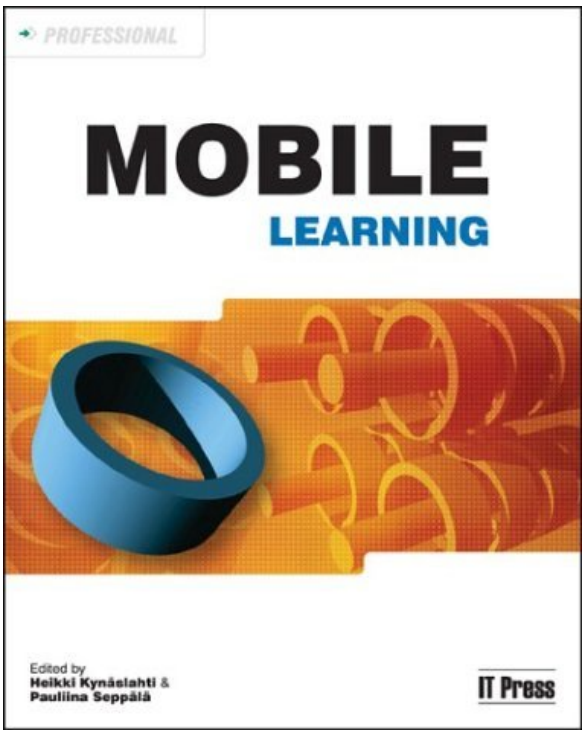
Product Details

Paperback: 250 pages

Publisher: Cromland (March 31, 2003)

Language: English

ISBN: 9518266905

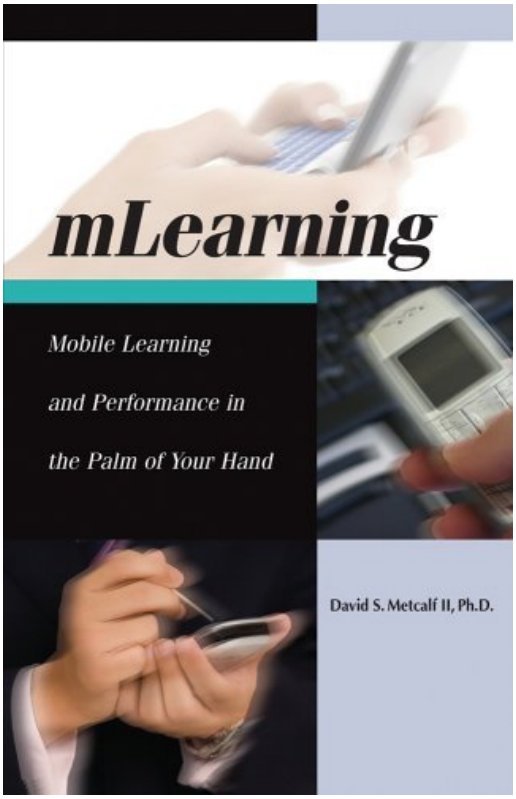


Amazon ref:
http://www.amazon.com/gp/product/0874259061/sr=8-12/qid=1140496737/ref=sr_1_12/002-2832778-0157626?%5Fencoding=UTF8

M-Learning: Mobile E-Learning (Paperback)
by David S. Metcalf

Product Details

- **Paperback:** 157 pages
- **Publisher:** HRD Press, Inc. (January 1, 2006)
- **ISBN:** 0874259061



Publisher ref:
http://www.hrdpress.com/s.nl/sc.2/category.4/search.M-Learning/.f

Bio ref: http://www.trainingoutsourcing.com/lt/whoswho_leaders.asp
A frequent speaker at major learning and development conferences around the world, Dr Metcalf is also the co-author of the book titled: Blended eLearning: Integrating Knowledge, Performance Support and Online Learning and recently participated as chapter author on "Operational Excellence Through Blended Learning" for Elliott Masie's upcoming book- Rants, Raves and Reflections in Learning. **He is currently completing mLearning: Mobile Learning and Performance scheduled for later this year.**

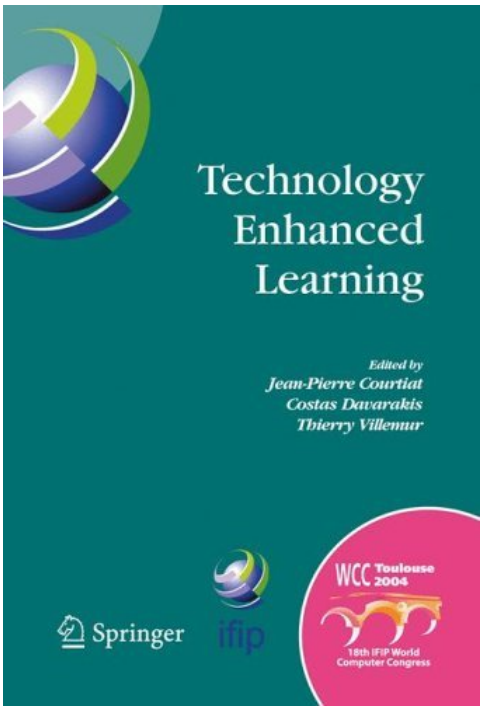
Other ref: http://mobilemind.net/archive/2006_01_15_mobilemind_archive.html
M-Learning: Mobile E-Learning **by David Metcalf seems to now be available as a book on the HRD Press web site. It was originally slated for a late 2005 release.** Though I've hosted a webinar on mobile learning with David and we speak with each other at trade shows, I haven't seen the book yet. His presentations are great and I do like his other book. (Tom King)

Amazon ref:
http://www.amazon.com/gp/product/0387240462/sr=8-33/qid=1140497250/ref=sr_1_33/002-2832778-0157626?%5Fencoding=UTF8

Technology Enhanced Learning : IFIP TC3 Technology Enhanced Learning Workshop (Tel'04), World Computer Congress, August 22-27, 2004, Toulouse, France (IFIP ... Federation for Information Processing) (Hardcover)
by Jean-Pierre Courtiat (Editor), Costas Davarakis (Editor), Thierry Villemur (Editor)

Editorial Reviews
Book Description
Technology Enhanced Learning is an essential reference for both academic and professional researchers in the field of institutional and home education. Technology Enhanced Learning (TeL) has provided tools and infrastructure to education and training disciplines for over a decade. The papers presented in this volume cover research issues including pedagogical and evaluation theories, integrated learning environments, e-learning experiments, trials and overall results from actual TeL deployment. This state-of-the-art volume contains a compilation of select papers presented during the Technology Enhanced Learning (TeL) workshop co-located with the World Computer Congress, August 2004, in Toulouse, France.

Product Details
- **Hardcover:** 188 pages
- **Publisher:** Springer; 1 edition (January 14, 2005)
- **Language:** English
- **ISBN:** 0387240462
- **Product Dimensions:** 0.5 x 6.2 x 9.5 inches



Author Driscoll, Margaret, 1959-

Title **Advanced web-based training strategies : unlocking instructionally sound online learning / Margaret Driscoll, Saul Carliner.**

Published San Francisco : Pfeiffer, c2005.

"Advanced Web-Based Training Strategies fills the gap in the literature available on this topic by offering a volume that includes meaningful, applicable, and proven strategies that can take the experienced instructional designer to the next level of web-based training. Written by Margaret Driscoll and Saul Carliner - internationally acclaimed experts on e-learning and information design - Advanced Web-Based Training Strategies provides instructional designers, e-learning developers, technical communicators, students, and others with strategies for addressing common challenges that arise when designing e-learning. Balancing educational theory with the practical realities of implementation, Driscoll and Carliner outline the benefits and limitations of each strategy, discuss the issues surrounding the implementation of these strategies, and illustrate each strategy with short scenarios drawn from real-world online learning programs representing a wide variety of fields including technology, financial services, health care, and government."--BOOK JACKET.

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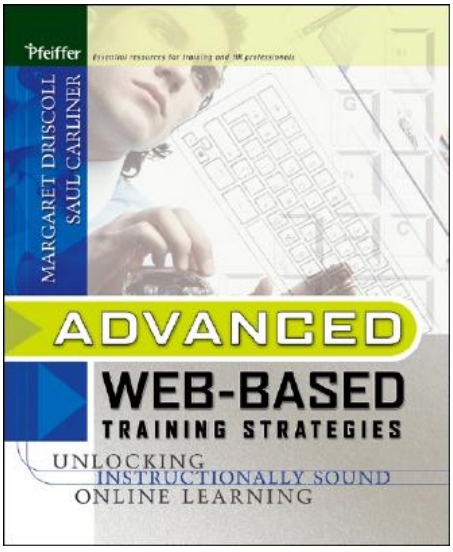

Conference IFIP TC3/WG3.3 Working Conference on eTRAIN Practices for Professional Organizations (5th : 2003 : Pori, Finland)

Title **E-training practices for professional organizations : IFIP TC3/WG3.3 Fifth Working Conference on eTRAIN Practices for Professional Organizations (eTRAIN 2003), July 7-11, 2003, Pori, Finland / edited by Paul Nicholson ... [et al.].**

Published Boston : Kluwer Academic Publishers, c2005.

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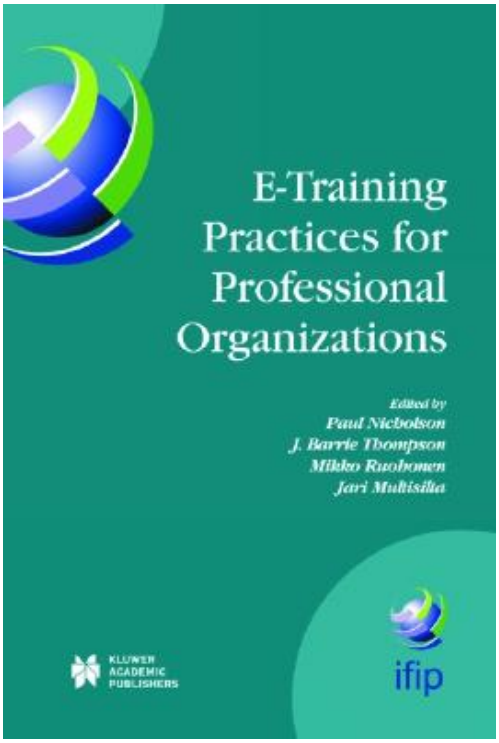
- Accessibility and mobile learning / Antti Syvanen, Mikko Ahonen, Anu Jappinen, Marika Pehkonen, Hanne Turnen, Teija Vainio 281
- Developing time-sensitive hypertext linking and navigation support / Anneli Heimburger 291
- Virtual learning modules for trainees / Heike Koppe 299
- A new spider on the Web / Arthur Tatnall, Bill Davey 307
- Logistics for learning objects / Bernd Tschiedel, Aleksander Binemann-Zdanowicz, Bernhard Thalheim 315
- Implementing the learner-centred design paradigm for Web-based training curricula / Panagiotis Zaharias, Angeliki Poulymenakou 325
- Implementation and use of a Web-based learning environment / Juha Lindfors 333



IFIP TC3/WG3.1 & WG3.3 Working Conference on ICT and the Teacher of the Future (2003 : Melbourne, Vic.)

Title **Information and communication technology and the teacher of the future : IFIP TC3/WG3.1 & WG3.3 Working Conference on ICT and the Teacher of the Future, January 27-31, 2003, Melbourne, Australia / edited by Carolyn Dowling, Kwok-Wing Lai.**

Published Boston : Kluwer Academic Publishers, c2003.

Table of Contents

Title **Intelligent virtual world : technologies and applications in distributed virtual environment / editors, Timothy K. Shih, Paul P. Wang.**

Published New Jersey ; London : World Scientific, c2004.

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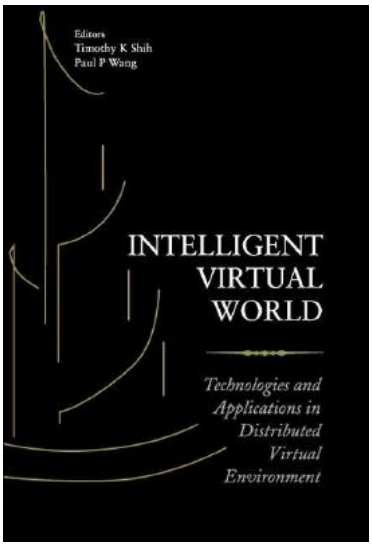

Title **Educating managers with tomorrow's technologies / edited by Charles Wankel and Robert DeFillippi.**

Published Greenwich, Conn. : Information Age Pub., c2003.

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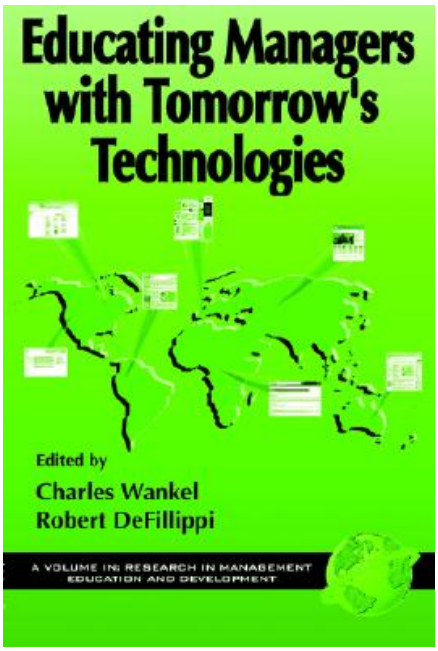

Author Cornford, James, 1963-

Title **Putting the university online : information, technology, and organizational change / James Cornford and Neil Pollock.**

Published Buckingham [England] ; Philadelphia : Society for Research into Higher **Education** & Open University Press, 2003.

"James Cornford and Neil Pollock draw both on theories from the sociology of technology and on a large and diverse body of empirical research in order to explore how universities are attempting to build and use new ICTs to sit alongside, complement and, in some cases, replace established means of delivering, organizing and managing higher education. Their book will help sensitize policy makers, academics, university managers, and students to the limits to, and implications of, the pursuit of a virtual future for higher education."--BOOK JACKET.

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Title **The virtual university? : knowledge, markets, and management / edited by Kevin Robins and Frank Webster.**

Published Oxford : Oxford University Press, 2002.

The virtual university? / Kevin Robins and Frank Webster -- Globalizing the academy / John Urry -- The university and modernity: a history of the present / Gerard Delanty -- The university and the 'global' economy / Masao Miyoshi -- **Working through the work of making work mobile / James Cornford and Neil Pollock** -- The virtual university : the learner's perspective / Charles Crook -- New managerialism : the manager-academic and technologies of management in universities--looking forward to virtuality? / Mike Reed and Rosemary Deem -- Exporting management : neo-imperialism and global consumerism / Yiannis Gabriel and Andrew Sturdy -- Saving the soul of the university : what is to be done? / Lee Benson and Ira Harkavy -- Commodity and community : institutional design for the networked university / Philip E. Agre -- Marketizing higher education : neoliberal strategies and counter-strategies / Les Levidow -- Digital discourses, online classes, electronic documents : developing new university technocultures / Timothy W. Luke -- Rehearsal for the revolution / David F. Noble -- Some consequences of the new information and communication technologies for higher education / Martin Trow.