A Framework for Mobile Learning Pedagogy

A Critique underpined by Constructivism

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Executive Summary

This report was commissioned to examine the Pedagogical aspects of mobile learning within the European Union. The research carried out by the partners of the project, draws attention to the current learning methodologies. We then look at current trends in mobile learning and discuss the proposal of a Mobile Learning framework.

The pioneering use of education technology has required a significant investment of time, energy, imagination and expertise to address economic, technical, social and pedagogical challenges.

The information on research was collected by the project team with strong support from a small group of experienced and expert researchers drawn from various parts of Europe who met with the project team and also prepared and submitted a large amount of evidence in the form of summaries of research reports considered to be potentially useful. It was found that some areas of potential interest were covered but others less so, and consequently it was decided to draw on research conducted elsewhere in the world if this added some new insight which might be appropriate to European circumstances

The information on good practice was based on an initial literature search which led to the development of a framework. With strong support from existing research, the instruments were disseminated to experts in different member state. When the information had been analysed, a validation meeting took place involving the project team.

From the above analysis of research, good practice and principles, the following positive features seem evident: i) enormous variety of worthwhile activity; ii) continuing evidence that generally pupils' attitudes and motivation are strongly positive when using new technologies

The main points of the research are:

1. What is taught and what is learned?
2. The knowledge Society
3. Constructivism as the basis for a new pedagogy for mobile learning
4. E-Pedagogy
5. The changing technological environment
6. The emergence of mLearning
7. Adaptive learning Systems
8. Constructivism
9. m-Learning Framework
10. Strategic Aspects of Wireless and Mobile Learning

Chapter 1

What is Pedagogy? – Etymology

1.1 What is learning, and how to understand the learning process?

A fairly standard consensual definition is "a relatively permanent change in behavior *(sic.; it's American of course)* that results from practice." (Atkinson et al 1993). This is of course arguable, particularly the "practice" criterion. Others would accept changes in "capability" or even simple "knowledge" or "understanding", even if it is not manifest in behaviour. It is however an important criterion that "learned" behaviour is not pre-programmed or wholly instinctive (not a word used much nowadays), even if an instinctual drive underpins it. Behaviour can also change as a result of maturation—simple growing-up—without being totally learned. Think of the changing attitude of children and adolescents to opposite-sex peers. Whatever the case, there has to be interaction with the environment.

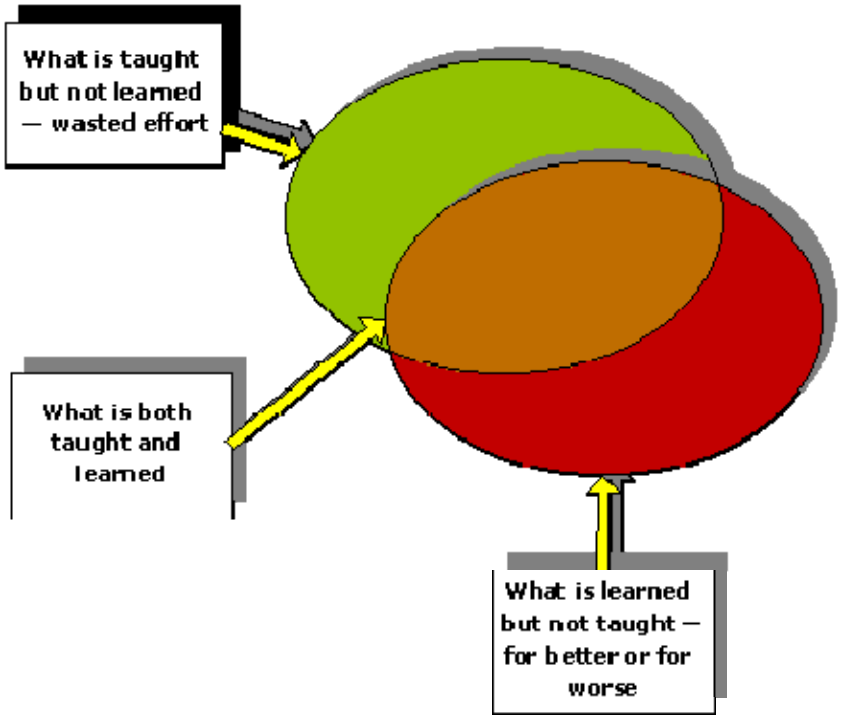
We are indeed becoming more confused: evidence from genetics, evolutionary psychology and neuroscience is arguing ever more strongly for predispositions for our behaviour. Locke's *tabula rasa* is getting dirtier by the minute: this is one of those areas for which Mark Twain's (attributed) comment might have been coined:

"Many researchers have already cast much darkness upon this subject, and it is probable that if they continue, that we shall soon know nothing at all about it"

Even if psychologists ever agree about what learning is, in practice educationalists won't, because education introduces prescriptive notions about specifying what ought to be learnt, and there is considerable dispute about whether this ought only to be what the teacher wants the learner to learn (implicit in behavioral models), or what the learner wants to learn (as in humanistic models).

What is taught and what is learned

It is a simple point that what is taught is not the same as what the students learn, but it does have a number of implications.



In the figure above, it is clear that some of what we teach is wasted effort: but the diagram is a representation of only one learner's learning. It may be that within a class as a whole, everything we teach is learned, by someone. The shape representing the teaching is smaller than that for learning, because students are also learning from other sources, including colleagues and the sheer experience of being in the educational system, as well as other more conventional resources such as books.

It is an open question in any given case as to whether what they learn apart from what they are taught is a "good" thing or not. It includes the "hidden curriculum", which is a phrase used by Snyder (1971) to describe what students learn by default in educational settings. His original observations at MIT in the late 'fifties were about how students with an over-loaded curriculum acquired survival tactics to get through their courses, such as mugging up only the parts which were likely to come up in the exams, and thus losing the point of much of the teaching. This selective learning is one of the characteristics of what is now called "surface learning", although that tends to be seen as an attribute of the learner — Snyder saw it as a problem of the institution.

From a sociological (Marxist) rather than primarily educational perspective, Bowles and Gintis (1976) suggested that all US schooling has a hidden curriculum dictated by the demands of a capitalist economy. More recently, critical theorists have sought to expose the hidden assumptions behind curricula (see, for example, Collins (1991) — see also Cultural Considerations). Some of the work seems marginal and academically political, but there is no denying that teachers' strategies, such as labeling, can have a profound effect on a student's experience. Claxton (1996) has convincingly argued that adult learning is profoundly influenced by "implicit theories of learning" acquired at school,

and that teachers tend to reproduce their implicit models in the ways in which they themselves go on to teach.

An important piece of research was carried out by David Kolb. David Kolb published his learning styles model in 1984. The model gave rise to related terms such as Kolb's experiential learning theory (ELT), and Kolb's learning styles inventory (LSI). In his publications - notably his 1984 book 'Experiential Learning: Experience as the Source of Learning and Development' Kolb acknowledges the early work on experiential learning by others in the 1900's, including Rogers, Jung, and Piaget. In turn, Kolb's learning styles model and experiential learning theory are today acknowledged by academics, teachers, managers and trainers as truly seminal works; fundamental concepts towards our understanding and explaining human learning behaviour, and towards helping others to learn.

Kolb's learning theory sets out four distinct learning styles (or preferences), which are based on a four-stage learning cycle (which might also be interpreted as a 'training cycle'). In this respect Kolb's model is particularly elegant, since it offers both a way to understand individual people's different learning styles, and also an explanation of a cycle of experiential learning that applies to us all.

Kolb includes this 'cycle of learning' as a central principle of his experiential learning theory, typically expressed as four-stage cycle of learning, in which 'immediate or concrete experiences' provide a basis for 'observations and reflections'. These 'observations and reflections' are assimilated and distilled into 'abstract concepts' producing new implications for action which can be 'actively tested' in turn creating new experiences.

Kolb says that ideally (and by inference not always) this process represents a learning cycle or spiral where the learner 'touches all the bases', i.e., a cycle of experiencing, reflecting, thinking, and acting. Immediate or concrete experiences lead to observations and reflections. These reflections are then assimilated (absorbed and translated) into abstract concepts with implications for action, which the person can actively test and experiment with, which in turn enable the creation of new experiences.

Kolb's model therefore works on two levels - **a four-stage cycle**:

1. Concrete Experience - (CE)
2. Reflective Observation - (RO)
3. Abstract Conceptualization - (AC)
4. Active Experimentation - (AE)

and a four-type definition of learning styles, (each representing the combination of two preferred styles, rather like a two-by-two matrix of the four-stage cycle styles, as illustrated below), for which Kolb used the terms:

1. Diverging (CE/RO)
2. Assimilating (AC/RO)
3. Converging (AC/AE)
4. Accommodating (CE/AE)

Kolb explains that different people naturally prefer a certain single learning style. Various factors influence a person's preferred style: notably in his experiential learning theory model (ELT). Kolb defined three stages of a person's development, and suggests that our propensity to reconcile and successfully integrate the four different learning styles improves as we mature through our development stages. The development stages that Kolb identified are:

1. Acquisition - birth to adolescence - development of basic abilities and 'cognitive structures'
2. Specialization - schooling, early work and personal experiences of adulthood - the development of a particular 'specialized learning style' shaped by 'social, educational, and organizational socialization'
3. Integration - mid-career through to later life - expression of non-dominant learning style in work and personal life.

Whatever influences the choice of style, the learning style preference itself is actually the product of two pairs of variables, or two separate 'choices' that we make, which Kolb presented as lines of axis, each with 'conflicting' modes at either end:

Concrete Experience - CE (feeling) **-----V-----Abstract Conceptualization - AC** (thinking)

Active Experimentation - AE (doing)**-----V----- Reflective Observation - RO** (watching)

A typical presentation of Kolb's two continuums is that the east-west axis is called the Processing Continuum (how we approach a task), and the north-south axis is called the Perception Continuum (our emotional response, or how we think or feel about it).

In the next section we can see that there are different aspects that must be explained and understood to fully grasp the learning process. From a psychological point of view, the following questions must be asked (Hagen, 2006)

Identity
• What are the influences on your identity?
• How is your identity influenced by your ethnicity, cultural background, age, gender, peer group, religion, sexual orientation, etc.?
• Who are you, who are you becoming, and who do you want to become?

Learning Styles
• What is your learning style?
• What strategies are most helpful based on your learning style?

Introduction to the Brain
• What do you wonder about the brain?
• Parts of the brain and their functions
• What does it mean to be “intelligent?”
• What happens if part of your brain doesn’t work the way it should?

Attention
• How attention helps you learn or make learning more difficult
• Common attention challenges
• Strategies for improving attention

Memory
• Understanding how memory works
• Different kinds of memory
• Strategies to help memory work more efficiently

Language
• Components of language (reading, writing, listening, speaking, understanding)
• Assessing one’s strengths and weaknesses in language
• Strategies for improving language skills

Social Cognition
• What are effective social skills?
• What makes someone popular?
• What makes someone a good friend?
• The role of peer pressure
• Strategies for succeeding in social situations

Learning Disabilities
• What are learning disabilities?
• How do learning disabilities affect one’s life in and outside school?

Putting It All Together
• Personal Plan of Progress

1.2 The Knowledge Society

The emergence of the knowledge society, building on the pervasive influence of modern information and communication technologies, is bringing about a fundamental reshaping of the global economy. Its significance goes well beyond the hyping of the Internet or the

dramatic declines in the dot.com sector. What is underway is a transformation of our economy and society. Knowledge has always been a factor of production, and a driver of economic and social development. Earlier economies depended, for example, on knowledge about how to farm, how to build and how to manufacture. However, the capacity to manipulate, store and transmit large quantities of information cheaply has increased at a staggering rate over recent years

The digitization of information and the associated pervasiveness of the Internet are facilitating a new intensity in the application of knowledge to economic activity, to the extent that it has become the predominant factor in the creation of wealth. As much as 70 to 80 percent of economic growth is now said to be due to new and better knowledge.

Information and communication technologies (ICTs) are also facilitating a rapid globalization of economic activity. In an increasingly global economy, where knowledge about how to excel competitively and information about who excels are both more readily available, the effective creation, use and dissemination of knowledge is increasingly the key to success, and thus to sustainable economic and social development that benefits us all. Innovation, which fuels new job creation and economic growth, is quickly becoming the key factor in global competitiveness. Innovation fundamentally means coming up with new ideas about how to do things better or faster. It is about making a product or offering a service that no one had thought of before. And it is about putting new ideas to work in enterprise and having a skilled work force that can use those new ideas.

1.3 Constructivism as the basis for a new pedagogy for mobile learning.

Does e-learning require a new pedagogy?
The teaching methods employed in the classroom have changed little in the last century. The school-master from 1907 would feel at home in the classroom of 2007. Teaching is almost unique in this regard.

Somewhat belatedly, education is now going through its own transformation. The effects of information and communication technology (ICT) are beginning to impact on education in a fundamental way. While the environment in which learning takes place has been revolutionised, learning theories and teaching methods have not changed. Some say that there is no need to modernise pedagogy; others argue that pedagogy also needs to be updated

Naismith et al (2004) introduced a classification of mobile learning activities where they categorised examples of learning via personal digital assistants (PDAs) and mobile ‘phones that involved children and the general public as well as university and college students, into six areas, four of which relate to the underpinning learning theory. These are behaviourist, constructivist, situated and collaborative. Two further categories relate more to context and application; informal and lifelong learning, and learning and teaching support. Of these six, the constructivist approach is most helpful in terms of

describing learning with mobile devices. Behaviourism considers only the relationship between a student's action and the response they receive without acknowledging any intermediary cognitive processing. And for me, situated and collaborative are more descriptions of ways in which learning may take place that could themselves be built into a constructivist learning activity rather than grounding theories within themselves.

The constructivist approach to learning is based on Piaget's (1950) original descriptions of how a child constructs their own understanding, building on previous understanding, and is currently predominant within the UK education system. The UK National Curriculum itself is based upon Bruner's (1966) ideas of a spiral curriculum where topics are revisited in turn at different ages in order to build upon previous learning. Papert (1980) himself built further on these ideas when he applied Piagetian theories to children's learning with computers to create the concept of constructionism. Constructionist learning involves the learner making their thinking explicit by, for example, designing a program in LOGO. This also allows the learner to see the results of their thought processes making it easier to revise or 'debug' them and, hopefully, building metacognitive skills.

Mobile devices lend themselves to constructivism, initial teacher training (ITT) students on teaching placement using PDAs would make notes in separate files, and later, through a process linked to further research and reflection, reconstruct those notes into a reflective essay demonstrating their learning (Wishart, Ramsden and McFarlane, in press).

The effectiveness of these kinds of activities is reinforced by this student's report "During teaching practice I have found myself constantly bombarded with new and noteworthy information (e.g. scientific facts, ideas for teaching approaches, school procedures, evidence for QTS standards etc.). The PDA has allowed me to keep meaningful notes of this information, and structure the information in a way that allows me to access it easily."

Another good example of PDAs being able to scaffold students constructing their own understanding is the use of Sketchy by school students. Whyley (2006), director of the Learning2Go Project where more than a thousand students in the UK have been using PDAs to support their learning lists Sketchy as a killer application for PDA use. He describes it as "A superb "Flickbook" animation tool, which learners enjoy using to illustrate their understanding of science concepts and other ideas". Constructing an animation is particularly helpful in supporting understanding dynamic concepts in science.

Motivation to Learn with Mobile Devices Challenge, Curiosity and Complexity
Bruner (1966) noted the importance of intrinsic motivation for learning in describing his technology of teaching, and proposed that the will to learn consists of both curiosity and the drive to achieve competence. These are produced, respectively, by the complexity and challenge of the task at hand. Later Malone (1981) applied both these concepts to explain the high motivation found in computer game players.

Malone (1981) explored the importance of cognitive, intrinsic rewards within the software as he analysed what makes educational computer games so involving for the player. He considers that the challenge of an educational software program is made up of a number of goals which vary during the program thus maintaining uncertainty within the user as to whether they will achieve them. When computer games of the 1970s were assessed by American schoolchildren the presence of a clear goal produced the highest correlation with popularity. This was closely followed by whether the game kept a score which also provides further challenge. Malone adds that complexity created by the use of graphics and sound motivates the computer user through evoking curiosity to explore the software. Pupils using a multimedia application whether on a desk top or a handheld can be seen to be satisfying this visual or sensory curiosity to see what images and sounds there are as well as following up their cognitive curiosity to know more about a topic. Malone (ibid) also considered the presence of a coherent fantasy intrinsic to the game being played to be important but this is less pertinent to the everyday use of PDAs for learning and teaching support in schools and colleges.

A good example of software that has been seen to evoke each of challenge, sensory and cognitive curiosity in users is the wildlife identification guide Wildkey. On trials with 23 schools across SE England 100% of the school teachers involved agreed or strongly agreed that using handhelds running Wildkey for wildlife identification and location reporting motivated their students (Bailey, 2006).

Chapter 2

E-Pedagogy

2.1 Does eLearning require a new approach to teaching and learning?

In school, colleges and universities today we can see that students still learn the way in the same way that previous generations have. So we must ask ourselves, why is this? From research carried out (Elliot 2006) we see that very little has changed in the way we educate ourselves. Some people argue a new approach is needed for both teaching and learning. The argument put forward is the modernizing of teaching facilities and current technology. For example, students in financially stable colleges in America can now download their class material through podcasts onto their iPods'. Also, students are given personal mobile devices and receive a text message when their lecturer has a message for them.

So the above points lead us to believe that while current ways of teaching and learning will always be with us, there is an opportunity. This opportunity is to there to be taken advantage of. We will look at the issues involved of making technology a catalyst for learning which will in turn require a new approach to eLearning. Various issues will be addressed and critiqued through this research. But before that, we will look at the nature of learning and the different theories of learning.

2.2 The nature of learning

There are numerous theories of learning. For the purpose of this paper, I will explain the main three types, but will consider one: **construction**

1. learning as behaviour (behaviourism)

2. learning as understanding (cognitivism)

3. learning as knowledge construction (constructivism).

Behaviourism

This psychological theory asserts that learning manifests itself in behaviour (either changed or reinforced behaviour), and behaviour can be conditioned through a system of punishments and rewards. Desired behaviours can be encouraged through rewards; undesired behaviours can be suppressed through punishments.

Behaviourism is one of the oldest teaching methods. It is typified by rote learning, drill-and-practice skill acquisition, and a punishment-and-reward system of learning. It is commonly practiced in primary schools and, to a lesser extent, secondary education.

Current assessment practice, in all sectors, exhibits a behaviouralist approach – rewarding success (with a "pass") and punishing failure (by withholding certification).

Behaviourism cares little about the mental processes that take place within the learner, who is considered a black box. Conversely, the teacher plays a central role, being 'master' with responsibility for training the learner.

In the behaviourist model, learning takes place in a highly controlled environment, through drill-and-practice techniques. It manifests itself through changed behaviours such as the acquisition of new practical or mental skills.

Cognitivism

Cognitive learning theories view learning as a process of understanding and internalising facts and concepts about the world around us. In the cognitivist model, knowledge and understanding are represented by discrete mental states; unique synaptic combinations that represent specific knowledge and understanding. Cognitivism takes a data processing approach to learning, with the learner being seen as a computer who inputs, processes and outputs information.

Cognitivism relies on both teacher and learner. The teacher provides content and leads learning (i.e. the creation of specific mental models); the learner is responsible for internalising the material presented by the teacher. In the cognitivist model, learning takes place when the 'correct' materials are available to the learner, and the teacher directs the learning. Cognitivism recognises the individual differences between learners, each having their own pre-conceived ideas and preferred learning styles. But knowledge remains essentially pre-determined, with the role of the teacher being to facilitate learning through a series of learning activities.

Constructivism

According to this theory, knowledge is entirely subjective, uniquely constructed by each learner through a combination of their existing knowledge and beliefs, and new stimuli. Knowledge is actively constructed by learners through a mental process of **development** through which learners build ("construct") meaning and knowledge. Meaning is derived from current knowledge and beliefs, and is individually constructed.

Piaget's (1977) notions of assimilation and accommodation describe how learning takes place. **Assimilation** refers to the integration of perceptions into existing mental models; **accommodation** involves the alteration of mental models to explain perceptions that would otherwise not be understood. Piaget asserts that learning occurs by an active construction of meaning, rather than by passive acceptance. He explains that when we, as learners, encounter an experience or a situation that conflicts with our current thinking, a state of disequilibrium is created. We must then alter our thinking to restore equilibrium or balance. To do this, we make sense of the new information by associating it with what we already know, that is, by attempting to assimilate it into our existing knowledge.

When we are unable to do this, which psychologists call a state of **cognitive dissonance**, we accommodate the new information to our old way of thinking by restructuring our present knowledge to a higher level of thinking.

In the constructivist model, the teacher facilitates learning – but does not direct it. S/he creates an environment (which may include learning materials) that is conducive to learning – but does not mandate it. There is no right and wrong; no target state of mind (unlike cognitivism).

Social constructivism is a variation on this model that focuses the social nature of learning. It emphasises the importance of culture, language and context in learning and borrows from Vygotsky's 'zone of proximal development' (1978), which argues that students can master concepts that they cannot understand on their own with the assistance of adults or peers who are more advanced.

The changing environment

Most of the world has been undergoing a cultural revolution during the last 25 years. This revolution has affected the environment in which students learn and, arguably, affected the nature of learners themselves.

2.3 The changing technological environment

A crucial aspect of this revolution is technological change. The most recent developments on the Internet are labeled "Web 2.0". Anderson (2007) describes six "big ideas" behind Web 2.0.

Perhaps the simplest way to explain Web 2.0 is to describe it as the "read/write web"; a web that facilitates participation and collaboration as well as information dissemination. This contrasts with the original "read only" web ("Web 1.0") where users were passive consumers of (other people's) information.

Ubiquitous computing relates to the widespread distribution of computing devices. It is currently at an early stage although mobile technologies (such as smartphones and PDAs) are a clear pre-cursor to a ubiquitous environment, where intelligent devices are routinely embedded in everyday objects (such as clothing and cars). Ubiquitous computing heralds a fundamental shift in society from an analogue world to a digital one.

The changing nature of learners

The wider societal changes that are part of this cultural revolution have affected the attitudes of young learners, who are typically less respectful of authority, less tolerant of poor service, and more self-motivated than previous generations. The shift from factory worker to knowledge worker has resulted in a constant demand for re-training and lifelong learning, leading to a much greater proportion of mature learners entering and re-

entering education. These older learners typically demand a flexible and relevant curriculum and one that recognises their existing experience.

New kind of learner

According to some commentators, the combined effect of these technological and societal changes is the emergence of a new kind of learner, variously described as "Millenials" (Oblinger, 2003), "Net Geners" (Barnes *et al,* 2007*)* and, most famously, "digital natives" (Prensky, 2001).

A common set of characteristics emerges from the literature with respect to their learning styles:

- skilled use of tools
- active learning rather than passive receiving of knowledge
- authentic learning experiences rather than contrived tasks
- construction rather than instruction
- task (not process) oriented
- search not memorise
- just in time learning
- doesn't know answer but knows where to find it
- Google not libraries

In his paper *Digital Natives, Digital Immigrants*, Prensky (2001) argues that there has been a fundamental change in students.

"Today's students have not changed incrementally from those of the past. A really big discontinuity has taken place. One might even call it a singularity – an event which changes things so fundamentally that there is no going back. This singularity is the arrival and rapid dissemination of digital technology in the last decades of the 20th century."

He goes on to argue that: "… our digital immigrant instructors are struggling to teach a population that speaks an entirely new language." Prensky touches on pedagogy when he describes how teachers must change: "Today's teachers have to learn to communicate in the language and style of their students… going faster, less step-by-step, more in parallel, with more random access."

2.4 The emergence of eLearning

As part of the technological revolution, the use of eLearning, or blended learning, is increasing. This is particularly true of Higher Education, which offers programmes partly or wholly online. In the future, eLearning is likely to be more widely used in the tertiary and school sectors. Another driver for eLearning is life-long learning, which requires on-going training and re-training of the adult workforce.

In many cases, eLearning is delivered through a virtual learning environment (VLE), which is a custom built environment designed for online learning. VLEs, such as *Blackboard* and *Moodle*, typically provide all of the software tools required for online learning such as communication and file sharing facilities. These environments are often modelled around the traditional campus, providing 'virtual staff rooms' and 'online student common rooms'. E-portfolios provide the digital equivalent to the traditional paper portfolio; these typically provide online storage for a range of media types (such as drawings, photos and videos). Dedicated e-assessment systems, such as *Questionmark*, facilitate large-scale online testing, providing many of the question types that are familiar to teachers.

Some academics have pointed out the potential of eLearning to improve current practice. Garrison and Anderson (2003) write:

"E-learning has significant potential to alter the nature of the teaching and learning transaction. In fact, it has caused us to face up to some of the current deficiencies of higher education, such as large lecturers, while providing some possible solutions or ways to mitigate these shortcomings. Seen as part of pedagogical solution, e-learning becomes an opportunity to examine and live up to the ideals of the educational transaction described previously."

2.5 New learning opportunities

The changing environment facilitates new kinds of learning. Teachers have traditionally focussed on content; indeed, many consider the identification and delivery of learning material to be their prime role. It is through this role that they seek to direct learning. But it has been argued that this traditional teaching skill is redundant in today's information-rich learning environment. A handout on the assassination of President Kennedy cannot match the resources that are available online, which typically include original text, audio and video materials. Some of this content is very high quality, even world class. The most talented Business Studies teacher would struggle to match an online master class in business management from Bill Gates.

Some commentators have suggested that the contemporary teacher should be more "guide on the side" than "sage on the stage". The ready availability of information makes *facilitation* more important than *direction*. The pedagogic challenge is not too little information but too much. The contemporary learner does not need to be supplied with information; s/he needs to learn how to select from the vast amount of digital information available online. They need to acquire 'new literacies': digital literacy, media literacy and (particularly) information literacy, the last of which includes the ability to "learn to learn".

The current educational system is highly synchronous. Everything runs to a timetable. But digital learning material is inherently asynchronous. Web pages can be accessed at any time; videos can be watched whenever a student chooses; and podcasts can be

listened to on the bus. The efficacy of traditional timetabled content delivery is questionable. “Face time” might be better spent discussing rather than delivering content.

New learning spaces

The emergence of ubiquitous computing is creating new learning spaces. Location is less important as information is available in almost any location where there is an Internet or 3G connection – ranging from *Starbucks* to the school bus. And it’s not just the location of spaces that are changing. The spaces themselves are transforming. Virtual worlds (VWs), such as *World of Warcraft* and *Second Lif*e, are attracting millions of users, and these worlds offer rich learning environments with a degree of emotional involvement unmatched in traditional settings.

For example, *Second Life* provides an environment consisting of millions of real life users who select an avatar that interacts with this world. There are thousands of in-world locations to explore, ranging from a virtual Rome to the dance floor on the *Titanic*. Users interact by text or voice. Streaming audio and video are available in many locations.

The educational applications of these environments are only now being considered. These include role playing and game-based learning. Some academics have argued that VWs could replace VLEs. Writing about the emotional involvement inherent in VWs, Bignell (2008) writes: “Traditional VLEs lack this engagement. By fostering the learning experience we can utilise the virtual world to produce amazingly effective teaching.” And he is confident about the future of such learning environments:

“Is *Second Life* better than 2D web-based virtual learning [VLEs]? Not yet. Will it be better? Yes, almost certainly, because the interactions are richer, the content easier to provide, the platform cheaper, the students can be engaged more readily, the technology is more efficient, assessment is easier, playful learning is afforded and tailored learning environments can be constructed for specific learning outcomes.”

2.6 Towards an e-Pedagogy

While the tools for teaching and learning have changed dramatically during the last 20 years, the methods of teaching and learning have not. Traditional teaching methods have been applied to these new learning environments. The reasons for this are two-fold: firstly, there is no need to change the tried-and-tested pedagogies; and, secondly, there are no alternative methods. The proponents of change challenge both of these assertions.

Problems with traditional approaches

The critics of existing approaches to teaching and learning make two arguments: (1) they’re not working; and (2) they misunderstand the nature of the technological change.

There are numerous critics of the *status quo* with respect to learning within higher education. Garrison and Anderson (2003) summarise many of the criticisms when they write:

"To realise the potential of eLearning it is essential that we rethink our pedagogy. Education is about ideas not facts. Moreover, students in higher education are not receiving the educational experiences they need to develop the critical and self-directed high education skills required for lifelong learning. The current passive-information-transfer approaches to Higher Education are contrasted with the interactive and constructive potential of eLearning."

Twist and Withers (2006) contrast the way teachers imagine students learn with the real way they learn. They call the ways in which young people actually learn the "hidden curriculum" – the "informal digital spaces", such as Facebook and MSN, which students routinely use for social and educational purposes.

Although school and university pass rates are improving (DfES, 2007), employers complain about the quality of school-leavers and graduates. Many employers claim that they are not properly prepared for the modern workplace, lacking the communication and collaborative skills needed in the contemporary working environment.

The second problem relates to faculty's view of new technology – as an educational tool, entirely separate from pedagogy. Some educationalists have claimed that this view is fundamentally flawed; that you cannot separate the medium (ICT) from the message (pedagogy). Cousin (2003) argues: "Pedagogies never live independently of the prevailing media. Technologies work dynamically with pedagogies, not for them, and in the process they become mutually determining." She was particularly critical of contemporary VLEs: "VLE environments (*sic*) tend to be skewed towards the simulation of the classroom, lecture hall, tutor's office and the student common room"; their adherence to existing pedagogy (the "primacy of pedagogy" as she put it) and focus on enhancing existing practice offered "false protection to academics because they promise a stable transition in an inherently unstable process of change from one media age to another."

The educational applications of virtual worlds illustrate this view. These environments provide new and unchartered territory for teachers – and one for which there is no pedagogy. VWs are not just another educational tool – they provide unique opportunities for teachers and learners, offering unprecedented levels of motivation and emotional engagement. They don't "fit in" with existing pedagogies. Rather, they have the potential to radically alter the educational experience. In the age of *Xbox* and multi-channel TV, perhaps VWs provide a way for education to claim its share of students' attention?

New pedagogies and learning styles

A number of new pedagogies have been proposed, all of which directly address the learning opportunities afforded by e-learning. Perhaps the best known of these is *connectivism* or *network learning*.

George Siemens introduced this theory in his paper *Connectivism: Learning as network creation* (2004) to address "the shortcomings of behaviourist, cognitivist and constructivist ideologies".

Connectivism conceptualises knowledge and learning as a network, consisting of nodes and connections. Knowledge, at any point in time, is a particular (probably temporary) configuration of nodes and connections (a sub-network). Learning creates new connections between existing nodes (changes to existing knowledge) and/or creates new nodes (entirely new knowledge). Learning, therefore, is about network (node and connection) creation. His theory differentiates between data, information, knowledge and meaning:

> **Data**: raw elements or small neutral elements
> **Information**: data with intelligence applied
> **Knowledge**: information in context and internalised
> **Meaning**: comprehension of the nuances, value and implications of knowledge.

"Learning is the process of that occurs when knowledge is transformed into something of meaning."

Connectivism embraces eight principles:

1. Learning and knowledge rest in diversity of opinion.

2. Learning is a process of connecting specialised nodes or information sources.

3. Learning may reside in non-human appliances.

4. Capacity to know is more important that what is currently known.

5. Maintaining connections is needed for continual learning.

6. Ability to see connections between ideas and concepts is a key skill.

7. Currency (accurate, up-to-date knowledge) is vital in learning.

8. Decision making is itself a learning process.

2.7 E-learning 2.0 and Assessment 2.0

'E-learning 2.0' (Downes, 2005) relates to the second phase of eLearning based around Web 2.0 technologies. It proposes that 'e-learning 1.0', which consists of VLEs, e-portfolios and other formal environments, be replaced by generic tools such as blogs, wikis, discussion forums and other Web 2.0 services. Similarly, in the paper entitled Assessment 2.0 (Elliott, 2008), it is argued that Web 2.0 services make better assessment tools than formal e-assessment software.

It has been argued that E-Learning 2.0 and Assessment 2.0 are inevitable evolutions of current practice (and will replace it); that 'traditional' VLEs and e-assessment systems are unnatural to students and cannot keep up with the rapid change (and growth) of Web 2.0 tools and services. Were this to happen, it would strengthen the case for connectivism since Web 2.0 can be seen a way of implementing this learning theory.

2.8 Adaptive learning Systems

Introduction

Advances in computer technology, intelligent user interfaces, context modelling applications and recent developments in the field of wireless communications, have created a wide array of new possibilities for technology users. When these technologies started to be used in education, a new learning paradigm, mobile learning, emerged. Thus, many new issues emerge and need to be explored. In this paper I am interested, in particular, on adaptation in mLearning. While adaptation in eLearning systems has attracted much attention, mobile learning is still struggling with basic technological and pedagogical problems. In fact, learning in mobile settings introduces certainly new dimensions of adaptation. So, the relevant questions which need to be answered are:
Did dimensions of adaptation in eLearning remain relevant in mLearning?
What are the differences between adaptation in eLearning and mLearning systems?
What to adapt in mLearning systems and how?
Many issues regarding adaptive mobile learning systems have not exhaustively been covered. Therefore, we are interested in our researches to adaptive mobile learning. Dealing with adaptation requires fixing initially adaptation dimensions. So, we begin with reviewing the literature in order to conclude most relevant dimensions in mLearning - those inherited from eLearning and those introduced by mobility
.
Then, I suggest a general framework that presents how to deal with dimensions in adaptive mLearning systems. The framework assembles different adaptation dimensions (user's model, user's context, devices and connectivity) and kinds (content, navigation, interaction, collaboration and presentation) in mobile learning and shows relationships between them with respect to the pedagogical aspect. This framework is considered in our researches that are interested in developing mobile learning environments based on an adaptive content and adaptive learning activities. Until now, an adaptive hypermedia system based on user's learning styles is already developed [Laroussi, 2001]. At present, our researches treat adaptive learning content and adaptive learning activities in mLearning

Mobile Age

We are now entering the mobile age, where phones are carried everywhere, banks are accessed from holes in the wall, cars are becoming travelling offices, airplane seats are entertainment centers, computer games are handheld, and advertising is ubiquitous. We now have the opportunity to design learning differently: to create extended learning communities, to link people in real and virtual worlds, to provide expertise on demand, and to support a lifetime of learning.

The entertainments industry is comparable in size and complexity to the education sector. One hundred years ago people travelled to music halls or concerts to be entertained. Then broadcasting and the gramophone brought mass entertainment into every home. Now a second revolution is underway as the internet enables people to create and share entertainment media across the world.

Adaptive learning Systems: from e to m

In the glossary of elearningeuropa.inf, eLearning is defined as: the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration. An eLearning environment is considered adaptive if it is capable of: monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process. [Paramythis, 2004]

Accordingly, adaptive eLearning systems carry out adaptation in accordance with a user model [Laroussi, 2001] which constitutes the main dimension of adaptation in adaptive eLearning systems.

What to adapt in eLearning?

According to [Paramythis, 2004], during an eLearning session we can adapt: interaction, course delivery, content discovery and assembly, and, finally, collaboration support.

- *Adaptive Interaction* refers to adaptations that take place at the system's interface and are intended to facilitate or support the user's interaction with the system.

- *Adaptive Course Delivery* refers to adaptations that are intended to tailor a course (or, in some cases, a series of courses) to the individual learner. The intention is to optimise the "fit" between course contents and user characteristics / requirements.

- *Content Discovery and Assembly* refers to the application of adaptive techniques in the discovery and assembly of learning material / "content" from potentially distributed sources /repositories.

- *Adaptive Collaboration Support*, is intended to capture adaptive support in learning processes that involve communication between multiple persons (and, therefore, social interaction), and, potentially, collaboration towards common objectives. The availability of high bandwidth wireless channels - such as 3G-telecommunication infrastructure, wireless LAN- and the popularity of handheld devices, has opened up new accessible opportunities for education. The true potential of eLearning as 'anytime, anywhere' has finally started to be realised with the advent of mobile learning (mLearning). Mobile learning can be defined as "... any service or facility that supplies a learner with general electronic information and educational content that aids in acquisition of knowledge regardless of location and time ..." [Lehner, 2002].

What to adapt in mLearning

Mobile learning can be considered from two viewpoints:

The first one is a technical oriented perspective. It points out that eLearning simply becomes mLearning by creating an additional channel of access for mobile users with mobile devices - such as hand phones, PDAs or pocket PCs-. The content suitable for eLearning needs to be used and then available in mobile environment.

The second one is a pedagogical oriented perspective. It points out that mLearning supports a new dimension in the educational process. Development of new skills and approaches will be required to ensure the pedagogical effectiveness of mobile learning.

We are interested in both viewpoints in order to fix dimensions of adaptation in mLearning. We consider transmitted dimensions from eLearning and those raised up by learning in mobile settings. With greater restrictions posed on mobile learners due to time, space and varied technical solutions available in different circumstances, adaptivity is expected to play even a greater role [Kinshuk, 2003b]. In fact, interesting possibilities arise with adaptive mobile learning environments and additional issues that do not usually apply in eLearning environments become relevant.

The user model dimension of adaptation in eLearning is still relevant in m-learning [Bull, 2003]. However, supplemental features gain importance. In fact, the user model is extended with user’s contextual information.

Also, new dimensions of adaptivity, provoked by the mobility will appear. These are mainly: device dimension and connectivity dimension. [Trifonova, 2004] [Goh, 2002]

The user model dimension

Location and general context are new features to be considered. Indeed, some environments take the user's location or some aspect of the general context into account, in order to present information or provide an interaction relevant to the learner's situation. An illustration is [Zancanaro, 2003] a museum guide which uses infrared sensors in order to present multimedia information related to the fresco painting in front of which the user is standing. However, this kind of application does not necessarily adapt to the individual. All users in the same location may receive exactly the same information. [Jameson, 2001] argues for combining research in the fields of context awareness and user modelling. An example of such an approach is the LISTEN system [Zimmerman, 2003], which provides audio presentations according to the location and also the profile of a visitor to an art exhibition. These kinds of approach unite the fields of context awareness and user modelling in applications can be highly adaptive not only to relevant contextual information, but also to the needs or interests of an individual user. The features of learner context are mainly: location, level of noise, temperature, light, objects in proximity of the learner, motivation, level of concentration and so on.

The device dimension

It's crucial to consider capabilities of user's devise for the mobile learning adaptation due to the fact that they have a big impact on what content is possible and meaningful to be delivered. Mobile adaptation to devise should consider the device's hardware and software attributes. *Hardware attributes* include: size and resolution of screen, Multilanguage capability, input possibilities (keypad, keyboard or pointer device), memory capability, processing power, cookies, supported media types and capabilities in presenting multimedia content, and so on. *Software attributes* include: operating system, compatible applications and so on.

The connectivity dimension

It's one of the main differences if we compare a mobile device with the PC (the usual medium for delivering eLearning). Nowadays mobile devices might be connected to 'The Net' via many technologies –WAP, GPRS, UMTS, Bluetooth, WiFi, etc. Mobile devices often have periods of disconnection, either intentionally (when the connection is too expensive) or not (when no infrastructure is provided). [Trifonova, 2004] [Goh, 2002] consider that under this dimension, there are four operating sub-dimensions. The user can operate in a real-time online sub-dimension mode. In this aspect, the operating connecting speed and throughput determine some of the adaptation capability such as multimedia representation or text-based representation. Another sub-dimension is the pre-fetching capability of the application. While static pages can be pre-fetched easily, interactive applications need further consideration such as the depth of pre-fetching. Here device capability and network reliability and connecting type are the main consideration for adaptation. The third sub-dimension is the off-line synchronization sub-dimension. Here the attributes of depth and encrypted cookies need to consider providing seamless adaptation especially for highly interactive application where parameters regarding users'

actions need to be returned to the server. The last sub-dimension is the channel sub-dimension. This sub-dimension represents the actual mode of connection between the users and the server. For example in a satellite connection the user can experience a longer delay than a cable connection and a hot spot Bluetooth connection might not be suitable to support rich multimedia. Mobile adaptation must take this dimension into consideration.

Chapter 3

Constructivist Learning

Constructivist learning has emerged as a prominent approach to teaching during this past decade. The works of Dewey, Montessori, Piaget, Bruner, and Vygotsky among others provide historical precedents for constructivist learning theory. Constructivism represents a paradigm shift from education based on behaviorism to education based on cognitive theory. Fosnot (1996) has provided a recent summary of these theories and describes constructivist teaching practice. Behaviorist epistemology focuses on intelligence, domains of objectives, levels of knowledge, and reinforcement. Constructivist epistemology assumes that learners construct their own knowledge on the basis of interaction with their environment. Four epistemological assumptions are at the heart of what we refer to as "constructivist learning."

1. Knowledge is physically constructed by learners who are involved in active learning.

2. Knowledge is symbolically constructed by learners who are making their own representations of action;

3. Knowledge is socially constructed by learners who convey their meaning making to others;

4. Knowledge is theoretically constructed by learners who try to explain things they don't completely understand.

With these common assumptions, teacher planning according to the Tyler or Hunter models is no longer adequate. Research indicates that few classroom teachers plan using these models anyway (Morine-Dershimer, 1979; Zahorik, 1975) and usually because of administrative pressure if they do (McCutcheon, 1982). However, few approaches are available for working with prospective teachers or new teachers to organize for learning. Simon (1995) and Steffe & Ambrosio (1995) describe their processes of planning for constructivist learning and constructivist teaching respectively, but these methods are complex and represent the thinking of experienced teachers.

We are proposing a new approach for planning using a "Constructivist Learning Design" that honors the common assumptions of constructivism and focuses on the development of situations as a way of thinking about the constructive activities of the learner rather than the demonstrative behavior of the teacher. Most conventional teacher planning models are based on verbal explanations or visual demonstrations of a procedure or skill by the teacher which are then combined with practice of this method or skill by the student. Much of this approach seems consistent with the description of classroom activities reported in a major research study titled *A place called school* conducted by Goodlad (1984). He found that most of the time, most of the teachers talk to the kids. Students explained that physical education, fine arts, or industrial arts were their most interesting classes because they actually got to do something. They were active

participants in learning rather than passive recipients of information. This is the primary message of constructivism; students who are engaged in active learning are making their own meaning and constructing their own knowledge in the process.

3.1 Constructivist theory

Formalization of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of *accommodation* and *assimilation*, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individuals' experiences are aligned with their internal representations of the world, but may also occur as a failure to change a faulty understanding; for example, they may not notice events, may misunderstand input from others, or may decide that an event is a fluke and is therefore unimportant as information about the world. In contrast, when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way and it violates our expectations, we often fail, but by accommodating this new experience and reframing our model of the way the world works, we learn from the experience of failure, or others' failure.

It is important to note that constructivism itself does not suggest one particular pedagogy. In fact, constructivism describes *how learning should happen*, regardless of whether learners are using their experiences to understand a lecture or attempting to design a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning by doing.

Social constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and multidimensional. Social constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilises and rewards it as an integral part of the learning process (Wertsch 1997).

An approach to learning developed by Seymour Papert and his colleagues at MIT in Cambridge, Massachusetts. Papert had worked with Piaget at the latter's Institute in Geneva. Papert eventually called his approach "constructionism." It included everything associated with Piaget's constructivism, but went beyond it to assert that constructivist learning happens especially well when people are engaged in constructing a product, something external to themselves such as a sand castle, a machine, a computer program or a book. This approach is greatly facilitated by the ready availability of powerful 'constructing' applications on personal computers. Promoters of the use of computers in education see an increasing need for students to develop skills in Multimedia literacy in

order to use these tools in constructivist learning. This is the point where we can focus on the use and importance of Mobile Learning.

ELearning (electronic learning) and mLearning (mobile learning) have started to emerge as potential educational environments supporting learning. Handheld devices or mobile devices, one of the most promising technologies, are here to support learning. Even though these new technologies offer new opportunities for individuals who require mobile computer solutions than other devices cannot provide, worldwide, these environments suffer from various technological as well as pedagogical problems

3.2 The importance of the background and culture of the learner

Social constructivism encourages the learner to arrive at his or her own version of the truth, influenced by his or her background, culture or embedded worldview. Historical developments and symbol systems, such as language, logic, and mathematical systems, are inherited by the learner as a member of a particular culture and these are learned throughout the learner's life. This also stresses the importance of the nature of the learner's social interaction with knowledgeable members of the society. Without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them. Young children develop their thinking abilities by interacting with other children, adults and the physical world. From the social constructivist viewpoint, it is thus important to take into account the background and culture of the learner throughout the learning process, as this background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process (Wertsch 1997).

3.3 The responsibility for learning

Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner (Von Glasersfeld 1989). Social constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike previous educational viewpoints where the responsibility rested with the instructor to teach and where the learner played a passive, receptive role. Von Glasersfeld (1989) emphasizes that learners construct their own understanding and that they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information.

3.4 The motivation for learning

Another crucial assumption regarding the nature of the learner, concerns the level and source of motivation for learning. According to Von Glasersfeld (1989) sustaining motivation to learn is strongly dependent on the learner’s confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgement and motivation (Prawat and

Floden 1994). This links up with Vygotsky's "zone of proximal development" (Vygotsky 1978) where learners are challenged within close proximity to, yet slightly above, their current level of development. By experiencing the successful completion of challenging tasks, learners gain confidence and motivation to embark on more complex challenges.

3.5 Pedagogies based on constructivism

In fact, there are many pedagogies that leverage constructivist theory. Most approaches that have grown from constructivism suggest that learning is accomplished best using a hands-on approach. Learners learn by experimentation, and not by being told what will happen. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not an "all or nothing" process but that students learn the new information that is presented to them by building upon knowledge that they already possess. It is therefore important that teachers constantly assess the knowledge their students have gained to make sure that the students' perceptions of the new knowledge are what the teacher had intended. Teachers will find that since the students build upon already existing knowledge, when they are called upon to retrieve the new information, they may make errors. It is known as reconstruction error when we fill in the gaps of our understanding with logical, though incorrect, thoughts. Teachers need to catch and try to correct these errors, though it is inevitable that some reconstruction error will continue to occur because of our innate retrieval limitations.

In most pedagogies based on constructivism, the teacher's role is not only to observe and assess but to also engage with the students while they are completing activities, wondering aloud and posing questions to the students for promotion of reasoning (DeVries et al., 2002). (ex: I wonder why the water does not spill over the edge of the full cup?) Teachers also intervene when there are conflicts that arise; however, they simply facilitate the students' resolutions and self-regulation, with an emphasis on the conflict being the students' and that they must figure things out for themselves. For example, promotion of literacy is accomplished by integrating the need to read and write throughout individual activities within print-rich classrooms. The teacher, after reading a story, encourages the students to write or draw stories of their own, or by having the students reenact a story that they may know well, both activities encourage the students to conceive themselves as reader and writers.

Chapter 4

mLearning Pedagogical Framework

The pedagogical aspects related to mLearning is to find ways on how mobile devices can be integrated into educational/training activities as well as successfully address all the parameters related to and influence mobile devices integration in education. A pedagogical opportunity is that the m-learning widens the educational horizons of students as well as enhancing the educational options for educators.

Pedagogical aspects of mLearning are connected to the processes that identify the needs of the learners, choose appropriate technologies, and design motivating experiences that efficiently meet learning objectives and result in better learning outcomes.

While designing pedagogical framework, three main aspects should be taken into account:

- Existing models of exploitation of the potential of new technologies in pedagogy (eLearning), as well as the user requirements related to pedagogical framework
- Educational characteristics and existing pedagogical practices among the partnership.
- Components of a 'best-practice' eLearning pedagogical framework.

mLearning pedagogical framework could consist of five components:

• Pedagogical framework context; defines areas that influence the framework itself and forms the basis for further development. mLearning pedagogical framework context focuses on mLearning theory and practice, motivational factors, strengths and weaknesses of mobile learning.

• Pedagogical approaches; promote particularly principles of constructivist theory, along with blended, collaborative and active learning.

In a constructivist approach, learners are encouraged to be active constructors of knowledge, mobile devices embedding them in a realistic context, at the same time as offering access to supporting tools. Compelling examples of the implementation of constructivist principles with mobile technologies come from a brand of learning experience termed 'participatory simulations', where the learners themselves act out key parts in an immersive recreation of a dynamic system.

• Assessment techniques; define and support diverse types of assessments. The question here is: if it's possible to use eLearning scenarios like including computer-based assessment, self-assessment, peer-assessment and tutor assessment?

• Current pedagogical practices in the partnership countries; different aspects of national specifics (national curricula and educational policy plans, existing pedagogical practices in the partners organizations, technical infrastructure and future users).

• Teacher training; supports teachers' work and endorse them during content production as well as delivery strategies decision. Techniques and methods to build a learning community encourage the participants to explore the systems as well as the materials.

In general, the authors from the literature raise the following concerns/questions connected to the pedagogical aspects of mLearning:

4.1 How mobile devices can be used in education/training process?

The authors identify mainly two approaches to mobile devices integration: 1) as a supportive tool; and 2) as an instructional tool. As a tool to support educators' mobile devices allow the recording and maintenance of the lessons take place, the instructional procedures, the type of mentoring and the pedagogical approach, the role of the teacher and students. Additionally, they facilitate communication between faculty members and students through file sharing capabilities, built-in networking and a friendly interface with on-line discussion and e-mail options.

On the other hand, mobile devices can be used as instructional tools to constructive learning. Mobile devices can be treated as tools that help students execute their tasks and promote the balanced development of their mental abilities by functioning as intellectual partners to the instructor and the learner. Educators can provide students with electronic books, internet reference sites, graphing calculator, dictionary, and thesaurus etc. Finally, electronic quizzes and tests can be taken through mobile devices.

4.2 Curriculum and learning materials development

The new mobile learning arena imposes significant new design requirements of the curriculum per se. These requirements are not limited to the ways in which it is delivered and received but moreover in the ways the curriculum is structured and the ways in which it is maintained. Curriculum units can be project-oriented and designed by adding a technological angle in well defined educational tasks. Furthermore, the social and the developmental value of each project task should be explicitly defined for each unit. Along the same lines, Colley and Steady (2003) address the need to produce innovative material that maintains a clear perspective on the learning goal. Activities within the curriculum can be designed to take place in classroom (deskwork) or mainly outside the classroom (fieldwork). It is unrealistic to support that mobile devices could be used for all classroom activities. As Carboni, et al., (2005) mention it is a complementary approach to the classic classroom lessons. It might not be able to deliver three hour course on a PDA but is it feasible to deliver small learning activities and a number of documents, and exercises. To produce materials and design the content to be appropriate

to stimulate and support the learner, knowledge of the technological constraints should exist. Consequently, to produce acceptable learning materials for mobile devices there is a need for educators, engineers, and computer scientists to collaborate and coordinate their actions and activities.

4.3 In what contents mobile technology could be used?

The contents which mobile devices can be applied vary. Research so far shows that the experiments took place in various fields such as: Business and specifically MBA classes, Accounting, English, Social Studies, Mathematics, Science and Geography classes etc. Other activities include innovative games, exploring museums and exhibitions. Additionally, mobile learning devices can be used in order to evaluate students learning as well as assess attitudes to learning.

4.4 What pedagogical methods and instructional approaches could be applied?

Some might suggest that mlearning technologies support individualism while others might say that it facilitates the application of constructivist techniques where collaboration and team work is enhanced and promoted. There is a need for a shared, progressive pedagogy for mobile learning that will provide the scientific basis for networked and collaborative learning in both a virtual and a virtual-augmented environment. It must accommodate different teacher and learner perspectives, promote learner-centered environments and collaboration among learners and between learners and educators. Finally, the new pedagogy must support ambient learning.

4.5 What is the role of the educators and the students in the design, development and implementation of the innovation?

Educators should be involved throughout the entire process of designing, developing and implementing mobile technology integration. They need to ‘accept’ and ‘embrace’ this innovation in order to successfully integrate it in their teaching practices; otherwise they might boycott it as in some cases they did with computer integration. Educators’ feelings have to be considered regarding this innovation. Positive and negative reactions are expected to emerge.

Educators’ willingness to integrate mobile devices in their settings should be examined. Along the same lines, students should be also involved in the process of mobile devices integration. Students need to have direct input on the process and features being developed. Additionally, educators need to be trained on how to apply mobile devices in their practices. To integrate computers in classroom practices, researchers were addressing the need that educators should be computer literate; in this case they have to be mobile literate. This is a greater challenge because they have to deal with various types of equipment (hardware) and software. Additionally, as Alexander (2004) supports the role of the educators needing to move towards facilitation and not teaching.

4.6 Collaboration among various stakeholders: educators, students/ learners, engineers, computer scientists.

Adopting an innovation is a risky process. But in order to minimize that risk and increase the success probabilities, it is important to be proactive and apply a systemic, holistic approach to mobile technology integration. The systemic approach to an innovation implies the involvement and participation of different parties in the design, development and implementation of the innovation. Various stakeholders such as educators, students/ learners, computer scientists and engineers should collaborate. Their collaboration is a critical element to successful mobile devices integration in education. The above stakeholders need to communicate, coordinate their actions, transfer and share their knowledge and experiences, as well as align their needs and goals. Educators need the help, support and knowledge of engineers and computer scientists and vice versa. It is not feasible to achieve mlearning without the coordination and knowledge integration of the above fields.

4.7 What are the educational benefits and gains that can be achieved?

It is reasonable and expected that some researchers, educators and practitioners are wondering and trying to understand what the educational benefits from mlearning are. Research showed so far that through mobile devices reluctant learners can be motivated, hard-to-reach learners can be reached, various skills can be developed and improved as well as better communication among learners and between learners and instructors can be achieved. Consequently, there is a need for some experiments to take place in order to examine the integration of mobile devices and their effects on various parameters such as students' learning, performance, and behavior, before moving further.

The implementation of the pedagogical framework is needed – we could use eLearning scenarios to implement the pedagogical framework and provide evaluation activities.

4.8 The need for a research in the pedagogical aspects of mLearning

Mobile devices are always available and can be used for a variety of learning functionality - providing access to content (both informational and instructional), review and assessment, and for communication and collaboration purposes. They can be used for formal or informal learning purposes as well as for performance support, i.e. for delivering information and support just-in-time and in context. Never in the history of the use of technology in education and training has there been a technology as available to citizens as mobile technology. It is clear that in the EU countries penetration is between 90% and 100%. Recent data from Telecom Austria shows that penetration of mobile services in Bulgaria currently exceeds 130 %. It is time to incorporate these technologies into the curriculum and into our design of student learning (Litchfield at al, 2007).

Mobile devices are popular and well used by many people within mLearning project target groups. They are regarded as personal technologies, and as such likely to encourage a positive response. With the current rate of development, mobile devices will

have the capability of delivering high quality, multi-media content at affordable prices within the next few years. If considering the fact that more people have mobile phones than computers we can assert that mLearning is more accessible than eLearning.

If we are interested in enhancing student learning, a priority must be to design mLearning and teaching strategies that involve active learning, for example, in experiential fieldwork, simulations, role-plays and games (Leigh, 2004). Learning and teaching strategies are needed that provide opportunities for learner adaptation and reflection (Laurillard, 1993), that encourage critical thinking, and that support students professional development through self and peer evaluation, feedback, review and assessment opportunities (Raban and Litchfield, 2007). Effective and practical strategies are needed that support learners to gain knowledge and skills in specific identified graduate attributes, curriculum objectives and stated learning outcomes.

In recent years there has been a lack of correspondence between the educational needs of the current generation of university students and much of the formal classroom education that takes place at universities. Ways of acquiring new knowledge for learners have been strongly influenced by the ICT's with which they have grown up. As well as being adept with desktop computers, young people are high users of mobile devices. For them the small screen of the mobile phone is 'a window to an infinite space' through which they are able to undertake the following learning processes: listening, observing, initiating, questioning, reflecting, trying, estimating, predicting, practicing and 'what-ifing' (Prensky, 2005). Nowadays learning can be characterized by a preference for receiving information quickly, coupled with the ability to process it rapidly; a bias towards multi-tasking and non-linear access to information; a heavy reliance on ICTs for information access and communication; and a preference for active involvement in learning over passive learning in lectures (Kennedy et al., 2006).

Trials in mLearning have been conducted at different universities in Australia, USA, Europe, (Litchfield at al, 2007) in order to extend the use of mobile devices and improve educational outcomes for the students. The trials showed that mobile devices can assist students to collect data in richer, multimedia formats and make subsequent classroom presentations of their field study much more interesting. However, it also showed certain usage and deployment issues with the mobile devices themselves, which were too difficult for most students to learn to use quickly in the short period of time they had. The authors conclude that device selection is crucial for the success of learning activities, and educational design should encourage students to use their own mobile devices which would be more familiar to the students and simpler to use.

There is a need to develop a new educational approach which will take into account the needs of the current learners' generation, while also providing for the diversity of learning needs in the student population. Such an approach needs to adopt deep learning - an orientation towards understanding, personal sense-making and active learning – since this will achieve better learning outcomes than surface approaches of memorisation, reproduction of knowledge and a lack of personal engagement (Prosser & Trigwell, 1999; Marton & Booth, 1997; Ramsden, 1992).

'mLearning' is the facilitation of learning and access to educational materials for students using mobile devices via a wireless medium. There have been an increasing number of investigative studies of mLearning over the last few years, mostly in the USA, Asia, Britain, Scandinavia, and Australia. Several researchers have used surveys of students and university lecturers as their starting point for investigating mLearning. Their objective has been to ascertain the extent of mLearning in university education and also to investigate the potential for leveraging mobile educational practice from existing mobile use. With the exception of a few notable large-scale implementations of podcasting in the USA (Thomas, 2006), and leaving aside many short-term projects, the university sector has not adopted mLearning. Interviews of professors at eight universities in Australia, New Zealand and the USA conducted by Al-khamaysah, Zmijewska, Lawrence & Culjak (2006) showed that none had adopted mLearning despite widespread use of eLearning. Most surveys of students show that few students use their mobile phones for learning. mLearning is currently in an exploratory phase with universities unclear about the case for investing in a new set of expensive technologies, and educators still testing different delivery applications. Other surveys have concentrated on the issue of 'threading innovative uses of technology into the existing fabric of behaviour' (Pettit & Kukulsksa-Hulme, 2007). These user-centred studies have focused on uncovering students' existing patterns of use and making these the basis for mobile education (Kennedy et al., 2006).

Of the mLearning projects found in the literature (Litchfield at al, 2007) the majority have been focused on improving interactivity in the classroom (Fujimura & Doi, 2006; Lindquist, Denning, Kelly, Malanai, Griswold & Simon, 2007) or on increasing students' access to learning materials anywhere, anytime (Barbosa, Hahn, Barbosa & Geyer, 2007; Cao, Tin, McGreal, Ally & Coffey, 2006). A smaller number of projects have focused on supporting on-the-job training in the field, largely for medical and nursing students in hospitals (Sommers, Hesler & Bostick, 2001; Sharples, Corlett & Westmancott, 2002; Kukulska-Hulme & Traxler, 2005). A few projects have included teaching students some aspect of mobile technology, such as programming PDAs or using stylus technology, usually in connection with ubiquitous delivery (Bradley, Haynes & Boyle, 2005; Miertschin & Willis, 2004; Alford & Ruocco, 2001). Occasionally projects have combined ubiquitous delivery with a focus on interactivity, for example, Sá & Carrico's mLearning framework (2006) although most studies have a single pedagogical focus.

There have also been criticisms of the methodology of some experiments. For example, Fies & Marshall (2006) note that most evaluations of mobile interactive classroom systems are flawed because they have focused on the comparison of traditional versus interactive teaching rather than mobile-supported interactivity versus interactivity with no mobile devices.

A small number of projects span more than one discipline area, for example Scheele, Wessels, Effelsberg, Hofer & Fries's (2005) interactivity study in computer science and education. Most projects focus on only one type of mobile device although we note that the current 'New Technologies, New Pedagogies' project being conducted by the University of Wollongong examines three major devices - mobile phones, PDAs and

MP3 players/iPods. Such project's need to expand into multi-institutional, multi-disciplinary approaches so that the outcomes are relevant to the widest community possible, using actual case studies in real class situations over a variety of subjects and education environments ((Litchfield at al, 2007).

There are identified specific problems in university learning that mobile technologies can help overcome, for example, limited real world context, limited access to learning resources, low student engagement in classes, and lack of practical experience in learning about mobile technologies.

Looking at the available studies on mobile learning above and more: Copley 2007, Gaskel, 2007; Roschelle, Sharps & Chan, 2005; Siemens, 2006; Sharples, Taylor & Vavoula, 2008, two main issues could be identified:

- *lack of operationalization of the referred theories into concrete learning design guidelines;*
- *evaluation of the effectiveness of the proposed mobile learning approaches is hard to find, and where it was the case, no strong research design was applied.*

The goal of the pedagogical framework of mLearning within this project is to define the pedagogical aspects of using mobile devices for learning purposes in different educational and training contexts. mLearning pedagogical framework includes:

- pedagogical framework context,
- pedagogical approaches,
- assessment techniques;
- current pedagogical practices,
- teacher training.

4.8 The need for a revision existing pedagogies and learning theories

Emergent technologies for learning demand that educators revisit existing pedagogies and learning theories. Those existing pedagogical frameworks may no longer be sufficient when learning is delivered using mobile devices. To continue to subscribe to existing models and practices of teaching and learning is to limit the learning experience afforded by these brave new technologies. In order to exploit the full affordance of mobile technologies it is necessary, at the very least, to re-examine existing pedagogies. Conversely, the phrase" Pedagogy before technology" is presented by Beetham and Sharpe, in their introduction to *Rethinking pedagogy for a Digital Age*. The suggestion being, rather than creating a new pedagogy for new technologies, it better serves the practitioner to locate new technologies within "proven practices and models of teaching". An evaluation of the impact of the Gutenberg printing press on learning, a study of how papyrus and paper first impacted learning, an analysis of the impact of mobile devices on learning, all of these innovations impact the learning process. The concept of mobile learning, knowledge on the move, has been described as nothing particularly new, (Denk, M., Weber, M, and Belfin, R. IJMLO pg 122-139 Vol 1. No 2). If mobile learning has

existed for some time, a new technological innovation is unlikely to cause a paradigm shift, with subsequent requirements for a new pedagogy.

The use of the word "pedagogy" in the field of mobile learning has given rise to debate about whether it is an appropriate term in a learner centred environment. The etymological basis of the word can be traced back to the Greek *Paidagogos*, i.e. the person who led the children *paidia* to school. "Pedagogy" can be taken to mean the art or science of teaching. This interpretation gives rise to questions in the vein of whether an equivalent term should be coined to focus on the art and science of learning, thereby bringing the focus back to the learner. From this, we can infer that teaching and learning are sometimes in tense opposition to each other. For the purpose of this proposal, pedagogy is taken to mean the underpinning models, practices and philosophy of both teaching and learning which structure the organisation and design of course content. These values, conscious or subconscious structure and shape every teacher and student's approaches to and expectations of learning.

The intention is analysis the theory of Constructivism as the basis of a pedagogy to inform or structure learning in a mobile environment. From radical constructivism, which denies the existence of an external reality, to a more measured approach, the basic tenets and standpoints will be examined in terms of how they may inform a pedagogy for mobile learning. The rejection of an ultimate shared reality as expounded by radical constructivists is an extreme standpoint; more measured exponents of constructivism acknowledge the existence of an ultimate shared reality. In this, more tempered view; each individual through their learning activities imposes meaning on the world. The learner through his or her learning activities imposes meaning on the world. The learners construct their knowledge and understanding through the learning experience, this knowledge is constructed rather than discovered

The basic tenets of these schools of thought may form the framework of pedagogy for mobile learning with far reaching implications. Examples are incorporating the need for students to acquire multiple perspectives or viewpoints on subject matter into the design of the mobile learning course. Also, the requirement to abandon rigid pre specified learning objectives will be examined, and how this will impact on the development of a mobile learning course.

In the Constructivist world, it is vital that students create or construct their own knowledge. Sitting in a classroom and passively receiving knowledge from an authority figure is not in keeping with the principles of Constructivism. Interactivity is emphasised, however, it is important to acknowledge that this requirement for interactivity is not merely satisfied by the adoption of a mobile technology into the classroom environment. It is incumbent upon the designers of a mobile learning course to ensure that students are truly able to interact with the digital media in their learning environment. These media as accessed through the mobile technologies, whether video, digital or audio are important aspects in the creation of a learner- centred environment. The overriding importance, however, lies not with the technology, nor the digital media, but with the knowledge constructed by the students as they interact with these tools.

The pedagogical framework informed by the Constructivist and Connectivist school places the student at the centre of the learning process. Because emergent technology is exiting and newly available, it is easy to become absorbed by the technology itself. This is true both for researchers in the area and for students employing mobile technology as learning tools. However, it is important that the technology itself does not become a distraction or a diversion. Again, poorly designed or ill structured mobile courseware or a Virtual learning Environment (VLE) may lead to frustrations and anxieties as students attempt to familiarise themselves with the system. Educators, developers and designers who strive for mobile learning environments with a sound pedagogical basis will take pains to avoid this occurrence. "An environment of tool should not be a hindrance, but rather an instrument for thinking and problem-solving (Fjortoft and Sageie, 2000)

A sound pedagogical framework based on developing the student's ability to think creatively and form multiple perspectives on subject matter requires courseware incorporating tasks and subject matter that are authentic and based in the real world. It is not sufficient to develop a series of exercises that demand completion simply for the aim of applying a principle of knowledge. It is incumbent upon educators and developers to draw the tasks from those that the student would be likely to encounter in a real world environment.

A personalised approach to learning is central to a pedagogy based upon the principles of Constructivism and Connectivism. The mobile device is a pedagogic tool that enables students to acquire knowledge at a personal level. In order to offer a truly personalised experience, it is necessary to first understand the learners existing skills and interests. The Futurelab report *Towards New Learning Networks* advocates the following " Currently most discussions about increasing learner 'choice' and 'voice' are focused around giving learners a greater variety of routes through predetermined and predefined subjects and curriculum content. However, a truly personalised system requires that learners will not only have greater choice and influence over the pace, style and content of learning but that they are also supported to become active partners in developing their own educational pathways and experiences".

This vision of students developing their own educational pathways requires that universities and colleges fully commit to the political agenda of personalisation. A starting point may be established in the creation of mobile learning courseware that exploits the affordance of mobile technology to personalise the learning experience.

A pedagogy that advocates personalised learning is one that also by necessity advocates a move towards more informal learning environments, moving outside the classroom. The mobile device is the ideal tool to foster informal learning. The mobile device affords location independent access to information services. "Professional knowledge is there for a purpose – to be used when professionals need to respond effectively within professional roles" Rhoda Sharpe and Martin Oliver consider Eraut's influential views on professional knowledge in *Rethinking Pedagogy for a Digital Age*. "Learning knowledge and using knowledge are not separate processes but the same process. The process of using

knowledge transforms that knowledge so that it is no longer the same knowledge". Sharpe and Oliver point to various studies to demonstrate difficulties encountered by professionals when asked to explain how they are applying their knowledge and making decisions. They write that tacit knowledge is unexpressed and difficult to capture, posing difficulties when attempting to design effective case studies for students to study. This leads the authors to advocate professional development that takes the form of observation, conversation or shared participation, all informal styles of learning, learning through social networks to access the knowledge of colleagues.

The formal and informal divide in learning is an interesting debate, however, it is also useful to view the difference as less of a tension and see these forms of learning as a continuum.

Sharples, Taylor and Vavoula in their paper "A Theory of learning for the Mobile Age" postulate a theory of mLearning in order to differentiate it from other forms of learning. The fact that mLearning is "labile" is not enough to distinguish it, learning is cumulative and occurs over a lifetime – we obtain our skills and ideas in one location and "apply and develop them in another". Mobility in itself is not the key to the difference, but by focusing on mobility we can, according to the authors, gain a better understanding of how knowledge and skills can be transferred across different environments and "life transitions" and how technology can aid us as a mobile society seeks to "cram learning into the gaps of daily life". A second criterion in their search for a theory of mLearning is the acknowledgement that much learning takes placed outside the typical learning environment, from cafes to cars, locations which are described by the authors as "impromptu sites of learning". Thirdly, the authors point to those practices that best enable successful learning and deduce that the social- constructivist approach is one which fosters successful learning. The last factor in their attempt to postulate a theory of learning is the ubiquitous use of personal and shared technology. The authors point to the convergence between new personal and mobile technologies and "new conceptions of learning as a personally-managed lifelong activity".

4.9 Pedagogical aspects of mLearning

The discussion on the main identified issue is centred on two questions: (a) what are the relationships between pedagogical approaches and technological affordances of mobile devices? and (b) which are the concrete characteristics of the pedagogical approaches that inform the instructional design guidelines for technology-enhanced mobile learning?

The debate on the pedagogical aspects of mobile learning is constrained by an 'either-or' type of argumentation about what is first, pedagogy or technology. Such a debate is not productive and reduces the chance of finding effective, efficient and appealing design solutions for mobile learning. Some of the existing traditional pedagogical approaches obviously are not appropriate for mobile learning. A survey conducted by Copley (2007) to measure the effect of audio and video podcasts on students' achievements and attitudes indicated that the approach was not effective in facilitating mobile learning. The very likely reason for this result is that just recording lectures as podcasts is not a really

challenging pedagogical approach to explore the full potential of mobile learning. Such results should be expected recalling the findings of an extensive meta-analysis study on the role of technology on learning (Russel, 2001, WCET, 2006; see also the study of Clark, 1994; and Kozma, 1994). The lessons from the past should carefully be analysed to avoid possible disillusionments. One of the findings is that the success of learning technologies depends on the extent to which they take into account the existing learning context (Bransford, in press?; Copley, 2007; Lee & Chan, 2007). It seems that neither teachers, nor students are prepared to fully benefit from mobile learning. Perhaps it is not only a question of using mobile learning for knowledge and skills acquisition, but rather changing attitudes and mental sets towards learning and teaching.

It is not technology or instruction alone that is the issue, but the need to find a right combination of both. Research on the effectiveness of mobile learning should analyse the conditions under which particular technology-instructional method combinations have an effect not only on different learning outcomes, but also on mental effort, satisfaction and invested time.

Most of the studies on the pedagogical aspects of mobile learning bring and maintain the discussion on a very general, paradigmatic level as little attempt is made to move to more concrete learning design level. (Copley 2007, Gaskel, 2007; Roschelle, Sharps & Chan, 2005; Siemens, 2006; Sharples, Taylor & Vavoula, 2008). Reasoning about which of the theoretical paradigms – behaviourism, constructivism, or the newcomer, connectivism, is more appropriate for mobile learning is certainly important to discuss. More important, however, is to operationally define them in concrete instructional design steps, guidelines, and structure of content, whose effectiveness, efficiency and appealing is further a subject of experimental investigation.

The traditional instructional methods apparently do not serve the purpose of mobile learning, but there are a number of pedagogical approaches which may match nicely to the technical affordances of mobile learning. Some examples of such approaches, but not limited to, are minimalism (Carroll, 1998), cognitive load theory (Sweller, 1994; see also Clark, Nguyen & Sweller, 2006)), anchored learning (Bransford et al, 2005), cognitive apprenticeship approach (Brown, Collins, & Duguid, 1996; 2002) jigsaw teaching (Bransford, in press), theory of problem solving cognitive style (Kirton, 2003), performance support system approach (Gery 2002; Greenberg & Dickelman, 2002), cognitive flexibility theory (Spiro & Jehng), peer teaching and assessment (Bransford, in press), and a set of principles (effects) of multimedia learning (Mayer, 2005) such as split-attention principle, modality principle, redundancy principle, segmenting, sequencing and learner pacing principle, guided-discovery principle, work-out example principle, and collaborative principle. The analysis of these theoretical approaches would identify the underlying principles that could be further used to formulate instructional design guidelines for constructing a mobile learning scenario. What follows is a possible blueprint of such a scenario. The scenario always begin with building challenges, which should resemble, as much as possible, workplace referent situations (anchored learning, cognitive flexibility theory, guided-discovery principle of multimedia learning), then the students collect the resources for the challenges, which could take any format (text, audio,

video). An important part in tackling the challenges are just-in-time, just-enough, and just-at-the-point-of-need advices (performance support system, worked-out example principle of multimedia learning) by experts (cognitive apprenticeship) and peer teaching from the fellow students (peer teaching and assessment). Experts and fellows help to build a multiple perspective view on the issue under investigation (cognitive flexibility theory). Students work first individually and then in small groups (collaboration principle of multimedia learning). Working in groups they get hints and learn how to manage the diversity of cognitive styles in order to cooperate effectively (jigsaw teaching, theory of cognitive styles for problem solving). The messages for mobile communication are based on some of the principles of minimalism (use as few words as possible, break the text into small, self-contained modules, usually no more than seven steps for procedures), cognitive load theory and multimedia learning (split-attention principles, modality principle, redundancy principle and segmenting, sequencing and learner pacing principle). Mobile technology offers unprecedented possibilities for combining the strengths of formal and informal education, and professional internship. This technology connects people working at different places (formal, informal, workplaces) with opportunities for expert and peer feedback and co-learning. Some ideas to enrich this scenario could be borrowed from Bransford et al (in press).

Lee and Chan (2007) have critically analysed the widespread belief on the technical affordances, which each mobile learning application should posses to facilitate learning. These attributes are spontaneity, personalization, informality, context-sensitivity, portability, ubiquity and pervasiveness. The analysis revealed that personalization and informality are not specific for mobility learning and they have already been achieved without using mobile technology. Portability, ubiquity and spontaneity are really unique technical mobile affordances but in practice they have coupled with inadequate instructional design solutions, as traditional desktop-based e-learning activities and content are just repackaged for a mobile platform leading to unsatisfactory results from pedagogical point of view. The assumption of the authors, shortly defined as ‘learning on the move, while in motion’ is that the design of pervasive, life style-integrated mLearning providing short, bite-sized pieces to facilitate an educational moment, will gain an increase in learning achievements. The study to test this hypothesis returned some encouraging results regarding the uptake levels and perceived effectiveness, but also some findings, which are not consistent with the pervasiveness of mLearning. People still preferred to listen to the podcasts using a desktop/laptop computer, at home in a dedicated time for it, and to manually download MP3 files via a web browser instead of taking advantage of the options offered by RSS (Really Simple Syndication). Lee and Chan struggled, in their initial attempts, to give a satisfactory explanation of the low score on multitasking, which is one of the operationalizations of the pervasiveness. Their conclusion is that rhetoric rather than empirical evidence is used to back the claim that “modern mobile technologies are time-savers, which allow students to multitask and promote a high level of life-style integration (p. 213)”. In fact, cognitive load theory and some of the principles of multimedia learning such as the split-attention effect can perfectly explain the results, if these theoretical constructs were taken into account in the design of mobile learning episodes. It is an example how such ‘middle level’ theories

which were listed above, could help the design and development of mobile learning applications.

Evidence-based conclusions about the effectiveness of mobile learning depends on how comprehensively and deeply the theoretical construct of mobile learning is defined and how well this phenomenon is operationalized in the terms of a research design - a right selection of type, sampling, variables, measurement instruments, procedure and data analysis.

Evaluation has been an underestimated issue in the reports on design, development and using mobile applications for educational and training purposes. It was either not discussed at al or when evaluation was reported, it had serious methodological flaws. In most of the cases the research methodology was a case study with one group as self-reporters as the preferred method for data collection. To our knowledge, there was no experimental study involving a control group. The studies returned inconsistent findings. While there was an overall enthusiasm among students to see more traditional learning materials transformed into mobile learning formats, the majority of students still see them as supplementary to the traditional forms mostly for revisions/preparation for assessment. A very low percentage of students indicated that mobile learning would increase their likelihood of not attending lectures (Copley, 2007). Very few students reported that they use mobile learning devices when engaging with other tasks. These results are in line with the conclusions of Lee and Chan (2007) on the very low number of students multitasking while using mobile learning devices. An interesting result of this study is that students were not prepared yet to use the full potential of mobile learning defined as 'learning on the move, while in motion'.

4.10 mLearning pedagogical framework

A mLearning pedagogical framework could consist of five components:

- Pedagogical framework context; defines areas that influence the framework itself and forms the basis for further development. mLearning pedagogical framework context focuses on mLearning theory and practice, motivational factors, strengths and weaknesses of mobile learning.
- Pedagogical approaches; promote particularly principles of constructivist theory, along with blended, collaborative and active learning.

  In a constructivist approach, learners are encouraged to be active constructors of knowledge, mobile devices embedding them in a realistic context, at the same time as offering access to supporting tools. Compelling examples of the implementation of constructivist principles with mobile technologies come from a brand of learning experience termed 'participatory simulations', where the learners themselves act out key parts in an immersive recreation of a dynamic system.
- Assessment techniques; define and support diverse types of assessments. The question here is: if it's possible to use device-based assessment, self-assessment, peer assessment and tutor assessment?

- Current pedagogical practices in the different countries; different aspects of national specifics (national curricula and educational policy plans, existing pedagogical practices in organizations, technical infrastructure and future users).
- Teacher training; supports teachers' work and endorses them during content production as well as delivery strategies decision. Techniques and methods to build a learning community and encourage the participants to explore the systems as well as the materials.

Chapter 5

Strategic Aspects of Wireless and Mobile Learning

In looking at the strategic aspects of wireless and mobile learning, we move to perspectives governed by concerns rather different from those of technology, learning and teaching. These are in many senses the context and the environment for the technical and the pedagogic aspects. They include:

> *Resources*: meaning obviously finance and money but also human resources, physical estates, intellectual property and expertise.
>
> *Culture*: meaning institutions as social organisations, their practices, values and procedures, but also their culture, that is the norms, expectations and standards of their staff, students and their wider communities, local, national and virtual.

In looking at these wider aspects of wireless and mobile learning, it is easy to start addressing far wider – too wide - questions of the processes of organisational change within post-compulsory education. To avoid this we should bear two questions in mind: does technology-based change in education differ from any other organisational change? And, does wireless and mobile-based change in education differ from other technology-based change?

Literature: there is a considerable and highly relevant literature around the issues of 'the diffusion of innovations' especially technological ones within organisations (starting from Rogers' seminal work, 1962), and of 'Academics Response to Change' (e.g. Trowler, 1998 and then, Knight & Trowler, 2001), some identified in the References and Resources section. Any attempt to understand, implement or change wireless and mobile learning within further, higher and community education must address the influence of technical and pedagogic concerns and also social, cultural and organisational factors. These can be formal and explicit or informal and tacit and can vary enormously across and within institutions.

5.1 Strategic Overview – Some Themes

In the course of looking at the strategic aspects of wireless and mobile learning, several themes have emerged. Institutions hoping to enhance and support learning with wireless and mobile technologies will need to recognise the significance of these and a number are identified below.

5.2 Projects

Projects, in this sense, are fixed-term and small-scale, with access to specific funds, expertise and enthusiasm. Projects usually refine or answer specific research questions, demonstrate specific technological or pedagogic possibilities and generate academic output.

Current projects in wireless and mobile learning are mainly 'first-generation', meaning that their focus is frequently on making the various technologies work, ensuring learning happens and satisfying funding conditions. These projects do not usually address issues of scale, embedding or quality, and technical challenges that often squeeze the time and resource available for evaluation. Consequently identifying explicit and objective improvements or costs can be problematic.

In these projects, wireless and mobile learning are usually implemented as enhancements or extras to core provision, often as a variation of conventional eLearning rather than as a new form of pedagogy. The most exciting, innovative and convincing examples of wireless and mobile learning are projects where new forms of learning are created, rather than where existing forms of learning are reversioned and ported, but these are most problematic in terms of institutions being able to guarantee the standard and quality of learning for their students.

Projects can sometimes form part of an institution's 'project economy' where researchers move on, and developments are not consolidated but they are nevertheless a useful way for institutions to gain experience of wireless and mobile learning. Information on projects can best be found in the relevant conference proceedings (e.g. Attewell & Savill-Smith, 2004).

5.3 Niches

Niches, in this context, are small-scale but sustainable initiatives, sometimes growing out of successful projects, based around a limited number of specific funding models. These models include:

- Specific subjects, for example, nursing, teaching practice, or medicine, where funding comes via training/professional agencies. Here wireless and mobile learning has self-evident virtues in enhancing effectiveness and efficiency, by delivering content and sustaining communications where there these would otherwise be difficult or impossible.

- Specific pedagogies, for example, fieldwork, field trips, outdoor pursuits, work-based learning, based around the ideas of situated or authentic learning, and for example, reflective logs, self-evaluation, e-portfolios based on the personal, immediate and accessible nature of mobile devices.

- Particular constituencies of learners who are prioritised and/or resourced, for example:

    - the Equal Opportunities, Assistivity, or Widening Participation constituencies where public funds support an inclusion agenda
    - full-cost courses, for example MBAs, where institutions use wireless and mobile learning to add value to their courses and compete with other

institutions in the market-place.

In the context of the current UK resourcing and structuring of further, higher and community education, there is unlikely to be general and over-arching support for institution-wide wireless and mobile learning. However, an understanding of the possibilities for sustainable wireless and mobile learning may allow institutions to support specific learners and specific learning in a sensible and effective fashion.

5.4 Producers, Manufacturers and Developers

The wider technical and commercial worlds of wireless and mobile technologies are important because they have considerable influence on the effective and increased deployment of wireless and mobile learning. The champions and managers of wireless and mobile learning within further and higher education must be alert for trends and developments.

Many hardware manufacturers see their mainstream wireless and mobile markets as technology-driven, highly segmented and very volatile, whilst seeing the further and higher education markets as fragmented and opaque, working to timescales, budgets and priorities unlike those of any retail or commercial markets. Some of these hardware manufacturers react to these perceptions by treating further and higher education as markets of secondary commercial importance whilst a very few have created models of constructive engagement and communication that open up possibilities for mutually beneficial collaboration. It would obviously be ultimately beneficial for learners if there were increased understanding and communication between producers, manufacturers and developers on the one side and further and higher education on the other, and there is perhaps a role for a national forum.

Some of the relatively few developers of software and content for mobile platforms predict a continuation of project-based funding, focussing on engaging new learners and delivering standalone content. They anticipate that some public funders will continue to support exploratory work in order to define the potential of wireless and mobile learning and that there will be a small but growing demand for the localisation and customisation of content, and for more support and training for teachers and lecturers. Institutions of further and higher education should be aware of these possibilities opening up.

The issue of standards is however problematic for developers working in wireless and mobile learning, since many of the technologies are immature, unstable and short-lived, requiring considerable developmental agility. Standards are seen as a potential brake on development, and interoperability may be best achieved using the levels of abstraction provided by browsers and other industry-standard software systems. Institutions of further and higher education should perhaps treat the standards issue pragmatically in order to encourage experimentation and evaluation.

Many different industrial trainers see a growing market for just-in-time training and performance-support delivered on wireless and mobile technologies for private sector

organisations. The development of wireless and mobile learning in further and higher education could exploit some of the models of mobile training used in the private sector but might also market its own models of wireless and mobile learning to companies and corporates.

5.5 Institutional Perspectives

In order to deploy wireless and mobile learning on a larger and sustained basis, its champions must present their case in ways that address parity with other forms of provision and delivery in terms of institutional concerns such as:

- costs, funding, resourcing
- quality, validation, fitness-for-purpose
- stability and reliability
- monitoring and evaluation
- legal expectations

Within an institution, several different bodies may articulate these various concerns and determine progress on an issue as potentially pervasive and systemic as wireless and mobile learning. This is because it has attributes that impact on major areas of institutional policy such as IT infrastructure and procurement, staff development and training, teaching and learning practices, and quality management. The 'ownership' of the each of the relevant policies usually resides with a different institutional custodian, such as the IT, QA and HR departments and their activities interact and interlock in ways that can slow down innovation and improvement.

Technical support staff, within an institution's Computer Centre or IT Department, are usually the custodians of institutional IT policy and when looking at wireless and mobile learning, are responsible for issues such as network security, hardware maintenance, interoperability, software support and IT procurement. All of these are potentially problematic, especially the issues of:

- network security and data protection
- interoperability with institutional software systems such as VLEs/MLEs, e-portfolios, portals, learning objects
- any pre-existing relationships, including procurement, with specific desktop PC systems, vendors and manufacturers, and their respective software systems
- support for staff members' and students' own devices.

A wider acceptance of support for student and staff members' own devices is one way that institutions can reduce pressure on their own resources, and this is especially significant if institutions are to exploit the increasing ownership of handheld computers and smartphones. The reluctance of some technical staff to allow academic staff to install software on their 'work' machines is also problematic since it inhibits experimentation and crucially prevents synchronising and backing-up mobile devices.

Technical support staffs usually have policy guidelines relating to mandatory, preferred and supported software systems. This policy is obviously derived from their work with desktop and laptop PCs and is potentially unhelpful if applied uncritically to mobile devices where the market-place is still evolving and the balance of the arguments about procurement is bound to be different.

Staff developers are the custodians of institutional HR policy and are faced with the training dimension of large-scale wireless and mobile learning. This may only be resourced if wireless and mobile learning forms part of institutional policy, or at least is not perceived to run counter to other existing policies. There are several models of how staff development could tackle issues of change in education. One model (Hall, 1974) looks at the need to address teachers' and lecturers' anxieties about change as well as addressing the need to up-skill.

If wireless and mobile learning are to become an established part of a course offered by an institution, then the institution's quality assurance procedures, looking at fitness-for-purpose on behalf of students, will expect answers to questions such as:

- Are the proposed course and the student experience comparable to that of a face-to-face course?
- Are the proposed course and its delivery mechanisms fair to all of its students or are some disadvantaged?
- Are the assessment procedures proposed using mobile learning technologies as rigorous, fair and objective as conventional techniques?

These are clearly challenging issues for a new pedagogy to address, and wireless and mobile learning will require 'second-generation' pilots or large-scale trials across institutions and across subjects if its wider potential is to be realised.

Wireless and mobile learning is currently treated by QAA as part of Flexible and Distance Learning in its general guidance to institutions. This guidance is relatively high-level and open to a considerable variety of interpretations at a local level. The view of wireless and mobile learning as fitting within Flexible and Distance Learning is potentially problematic for courses using wireless and mobile devices purely within the classroom. There is however increasing movement towards viewing wireless and mobile learning more holistically and looking at it in terms of a range of parameters including the balance of lone learning *vs.* cohort learning, on-site learning *vs.* off-site learning and face-to-face learning vs. remote learning. At a local level, specific institutions ability to validate innovative wireless and mobile learning provision may depend on whether the institution is coming up to or coming away from some inspection or audit, and whether validation procedures are highly formalised and centralised or not.

Every university and college now has a teaching and learning strategy and this usually has an eLearning component. The institutional strategy articulates the roles and responsibilities that underpin the strategy and this will usually include high-level learning and teaching 'champions' responsible for carrying out and carrying forward learning and

teaching in the institution. These champions are the custodians of institutional policy on teaching and learning and usually have a lead role in introducing and managing educational change across their institutions. This often involves mustering the resources, training and guidance (or indeed regulation) for embedding innovation and acting as the 'gatekeepers' to the wider use of wireless and mobile learning. It would usually be their responsibility to implement the practicalities of any institutional wireless and mobile learning policy.

Each of the case studies in (Kukulska-Hulme & Traxler, 2005) deals in part with these institutional issues and one in particular describes the introduction of institution-wide mobile learning.

One final and largely unresolved issue for more sustained wireless and mobile learning is the attitudes of students, potential students and teaching staff. Any initiative to introduce wireless and mobile learning can only successfully proceed if these attitudes have shaped the nature and extent of the initiative, in terms of the acceptability of the proposed devices, technologies, pedagogies and costs.

5.6 Strategic Overview – Possible Trends

The development of wireless and mobile learning in the post-16 sectors will take place in the context of various trends in the wider technical, social and commercial environment that will have considerable impact.

The leisure, retail, business and commercial markets will continue to drive mobile device design, marketing and pricing. This will mean that educational innovators will have to continue appropriating and adapting hardware and software technologies intended for other markets and other purposes.

It will also mean that many students, perhaps only the more affluent, will enter further and higher education already owning wireless and mobile devices. Educational institutions must accept and exploit this diversity of technologies, devices and connectivity, and use their own resources to maintain equity of access and use for less affluent students.

This will mean that institutions must be very flexible and responsive in working with a proliferation of platforms, systems and networks. There are several likely trends within the overall confusion and these may make the situation more manageable. Handheld computers (PDAs) are likely to continue to lose market share to smart-phones (with considerable connectivity and personal information management functionality), alongside a general migration of PDA functionality and potentiality into smart-phone devices and increased diversity and richness of connectivity. Handheld computers may also lose some market share to laptops and tablet PCs (with wireless connectivity and a widely recognised and accepted interface), though this is less likely to be significant amongst many potential students. The handheld computer market itself may see increased

segmentation and fragmentation as manufacturers try to define and exploit progressively more specialised niches, whilst the power and diversity of peripherals (cameras, keyboards, location-sensors) will also continue to increase. There may also be growth in the ownership and use of USB memory sticks (to carry personal content and eventually some processing), personal music players (with personal information management and file space) and games machines. The steady increase in urban and campus connectivity will favour laptops at the expense of handheld computers and phones, especially if GPRS and its successors continue to be rolled out. It seems possible that PalmOS (and Palm) will continue to be under pressure from Microsoft as the dominant platform (and perhaps from Symbian in smartphones and the new iPhone 3G).

Community, further and higher education will begin to see raised expectations amongst their younger entrants as wireless and mobile learning become more widespread in schools and sixth-form colleges.

In line with general social trends there will be increasing but unsupported handheld computer use by academic staff and possibly even greater laptop usage (and home-working), reinforcing concerns about cost issues, the length of the working day, loss of privacy and stress, many of which have already been explored in relation to networked learning (Bacsich et al, 1999).

Institutions in further and higher education currently seem relatively cautious about exploiting wireless and mobile technologies in teaching, learning, assessment and administration and its champions must recognise and explore the issues that this review has raised. These include:

- usability (and this must include SENDA compliance)
- network security
- the diversity and fluidity of devices, platforms and systems
- lack of staff expertise
- procurement, maintenance, ownership issues.

One type of wireless and mobile technology use that is somehow different from most of the others is SMS texting based on mobile phones. It is different mainly because institutions unusually do not have to procure or maintain the hardware – mobile phones are a ubiquitous and inclusive technology - and need only pay for bulk messages. The usability and interface are poor and the purely pedagogic exploitation is challenging. SMS texting does however present a unique opportunity for institutions to improve retention, efficiency and contact. A few large-scale pilots are now beginning to take place.

Recommendations

We are seeing an increasing and informed diversity of learning, teaching and administration taking place on a range of wireless and mobile devices; we can also expect to see a continued improvement in the performance, usability and connectivity of mobile devices and a gradual understanding of the affordances of mobile learning in the wider context of technology supported learning. This section looks at strategies that can take wireless and mobile learning to a sustainable and substantial position in UK post-16 education.

The way forward for an institution will obviously depend on a wide range of local factors, including its students' needs and preferences, its staff's expertise and enthusiasm and the institution's resources and organisation. There are however some tactics that will enhance the success of a wireless and mobile learning strategy:

- Projects will reward and support innovative lecturers, gain and publicise valuable early insights and give wireless and mobile learning positive local visibility.
- Exemplar content, lessons and courses across disciplines will give lecturers a sense of what they themselves could achieve; some of it should be 'quick-and-dirty' and invite imitation.
- High-level 'buy-in', managers seen using wireless and mobile devices, will increase credibility and status of wireless and mobile learning.
- Identification and exploration of potential revenue streams will enhance sustainability; some projects could specifically address this aspect of wireless and mobile learning.
- Recognition that mobile and mobile devices are 'personal' and encourage 'ownership' amongst lecturers – easy access to a range of mobile devices will develop familiarity, expertise and confidence.
- Reliable and robust technical support, infrastructure, network access and hardware will mean that lecturers can innovate – especially in front of 'live' classes - without risk.
- Standards introduced and developed only as experience accumulates, avoiding premature 'lock-in' to specific platforms or systems; the same is true of ways of measuring the progress and success of wireless and mobile learning.
- Sustained, timely and accessible staff development that addresses lecturers' pedagogic and technical worries; mixing 'just-in-case' with 'just-in-time'.
- Credible channels of evaluation, feedback and communication between students, lecturers and management will foster greater 'ownership' of the institutional strategy as it evolves.

Conclusion

From the above research we can see many possibilities in the area of mobile learning for students. We have looked at issues covering technology advances such as PDA's, laptops, mobile phones, smart phones etc. We have also looked at an m-learning framework. These aspects will and can act as enablers in the future for successful.

But for mLearning to be commercially successful, education institutions will have to promote and continue research into the idea. We currently see at the present time that people can study across large distances. It will also depend on the continuing development of mobile devices, hardware and software across mobile networks.

From the body of work we see that a number of factors can have an effect on mLearning. These factors may be environmental or bureaucratic. Such factors may include cost, red tape and politics with organizations, lack of investment or cultural indifference.

Our main conclusions from the mLearning pedagogical study:

- Most mLearning studies have been small-scale and implemented in only one discipline. There is a major need for large scale implementations generalised across a range of disciplines and subject areas and across institutions.
- The great majority of mLearning experiments have dealt with a single pedagogical issue, e.g. enhancing classroom interactivity. They have also usually focused on a single technology. There is a lack of a consolidated body of knowledge to guide teachers in implementing mLearning, particularly in the university sector
- A major challenge yet to be overcome is the cost of mobile hardware, software, connection and usage charges. The lack of sustainability of many mLearning projects indicates that this may well be the major difficulty to implementing mLearning on a national scale. There is a great need for the investigation of low-cost solutions to implementing mLearning so that it can be sustainable.
- There has been a lack of focus on designated groups of students. The assumption has generally been that al student groups have similar mLearning needs. Where studies have examined mLearning with different populations, the results are difficult to interpret because of inconsistencies in discipline areas. A proper evaluation needs to be made of the effectiveness of mLearning with international different groups of learners.

We present the methodology for the future research in mLearning pedagogy:

…*effectiveness*
Possible research question: What is the effect of mobile learning systems on students' and trainees' achievements and attitudes?

…*hypothesis*
The students in the experimental group, who work under a newly designed and developed mobile learning system, will score significantly higher than the students in the control

group, who study under traditional learning system on the items of a performance test. The students in the experimental group will outperform the students in the control group on scores of a reflective questionnaire's items indicative for positive attitudes towards the way of learning.

… *research design*
The research design is pre-test, post-test with a control group. It is possible to compare the learning achievements and attitudes of students, randomly assigned to experimental and control groups. The experimental conditions include an elaborated mobile learning scenario. The control conditions include a variation of traditional learning systems. The experimental design will also control for the variation of subject matter content. Apart from learning achievements and attitudes, the research design will measure the effect of cognitive style of students and, if feasible, time and mental efforts.

…*measurement instruments*
Four measurement instruments could be used for the purposes of testing the effectiveness of the mobile learning scenario. These are: a pre-performance test, post-performance test, a reflective questionnaire and Kirton's Adaption-Innovation Inventory for measuring problem solving cognitive styles. If needed mental effort will be measured with a special-purpose mental effort scale (Paas & Van Merriënboer, 1993).

We identify three main phases in such a research. We perform in this material the first phase – definition of the five components of the mLearning pedagogical framework. The research activities were based on existing models of exploitation of the potential of new technologies in pedagogy (eLearning), as well as the user requirements related to pedagogical framework; educational characteristics and existing pedagogical practices among the partnership and components of a 'best-practice' eLearning pedagogical experience. Future research will start with the implementation of the defined mLearning pedagogical framework in different contexts. In this phase there could be developed: mLearning scenarios according to the pointed issues of the investigation; evaluation methodology – evaluation plan, measurement instruments, research design; mLearning repository with technological framework, learning tools and courses content (implementation of existing mobile learning systems). During the third phase it could be conducted trials - usability and effectiveness testing.

When we looked at the strategic point of view mLearning, we discovered what we aimed for in the Executive Summary. Our findings suggest leisure, retail, business and commercial markets will continue to drive mobile device design, marketing and pricing. This in turn will have a knock on effect. It will also mean that many students, perhaps only the more affluent, will enter further and higher education already owning wireless and mobile devices. Educational institutions must accept and exploit this diversity of technologies, devices and connectivity, and use their own resources to maintain equity of access and use for less affluent students.

From the research carried out, we can see that our goals have been accomplished and the above body of work could also be researched further.

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