Modelling of the relationships between Mobile Device Technologies (MDTs) and UK educational practices

Motunrayo Olutoyin Remy Olasoji

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Dedicated to my past, present and future.

May those reading find my achievement inspiring and worth surpassing.

Declaration of originality

This thesis contain original work by the researcher and no parts of the thesis have been copied from any previous work from any other person or persons except those fully referenced and acknowledged as necessary. The study outlined in this thesis has not been submitted for any other degree programme at University of East London or any other university or higher educational institution.

Included papers and attribution

Excerpts from some of the sections in this thesis have been submitted as articles for publication or published in journal(s) / conference(s) / workshop(s) etc. Some of these include the following:

Chapter 4	**Requirement Engineering for Effective Mobile Learning: Modelling Mobile Device Technologies Integration for Alignment with Strategic Policies in Learning Establishments (ISEC'14)** R. Olasoji, D. Preston, A. Mousavi Paper presented at the Information Systems Education & Curricula (ISEC) 2014, in Warsaw, Poland (7-10 September, 2014). Published in the Proceedings of the 2014 Federated Conference on Computer Science and Information Systems for IEEEXplore Digital Library (pp. 851–860, ACSIS Vol. 2. DOI: 10.15439/2014F98).
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Abstract

This study investigates the state of the art of the concept and practice of Mobile Learning (ML) and the integration of Mobile Device Technologies (MDTs) in educational processes. Using a combination of techniques from Requirement Engineering (RE) and Agent Oriented Software Engineering (AOSE), the domain is explored and analysed for ongoing effectiveness and sustainability. Impressive advances in MDTs have made them pervasive and entrenched in many cultures, systems and in everyday living. In the last decade, the emergent of mobile / handheld devices, and subsequently, wireless technology standards have given rise to the concept of ML.

Although MDT was seen by many early on as part of the solutions for learning transformation, quantifying benefits and placement in teaching and learning, either to achieve learning objectives or enhance the process remain problematic. In spite of efforts in the last decade by researchers and educators, expected potentials for learning mobility and adaptability resulting from their use are largely unfulfilled. Rapid changes in development and manufacture also continue to present additional challenges.

Most research studies typically employ the approach of evidencing benefits through usage implementations and experimentation. In the review of this thesis, application of techniques provided in domain neutral RE and AOSE disciplines for specifying goals and requirements for complex systems is proposed. Alignment with teaching and learning strategies as well as institutional goals and strategies is considered essential for successful integration in any learning institution. Consequently, this review advocate strategies for alignment through elicitation and modelling techniques of RE and AOSE disciplines.

Requirement elicitation is carried out using a mixed methods of inquiry comprising of four phases in sequential & parallel investigations. Phase I involves literature / citation report analysis / systematic review and quantitative survey. Secondary quantitative data is also sought during this phase. Phase II

includes further in-depth quantitative and qualitative study. Questions used during this phase are designed from issues arising in Phase I. Phase III comprises of targeted studies among stakeholders in Higher Educational Institutions (HEIs), allowing for comparison of underpinning policies, cultures and practices; gaining an understanding of the concept and influential factors. Data gathering techniques include surveys, observations, interviews and focus group sessions.

Using both sequential and parallel mixed method of enquiry afford opportunities to establish a frame of reference and analyse opinions within the domain among relevant stakeholders: students, academics / educators, those in the role of learning support and governance and IT support personnel. The survey is analysed using descriptive statistical analysis techniques, also involving comparison of responses from all participating groups. Qualitative data is analysed using thematic methods

The review of this thesis contributes to the body of knowledge on ML as a concept and practice, evaluating definitions, frameworks and practices as relating to HEIs for the most part. Approaches to integration by selected HEIs are explored and analysed for effectiveness. A series of models is created illustrating the use of RE and AOSE techniques to align ML system requirements with organisational goals and strategies. Outcomes from the review will make it possible to advance research and knowledge forward for the practice of ML and integration of MDTs in educational processes.

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List of Abbreviations

Abbreviation	Description
2G	2nd Generation
3D	3 Dimension
3G	3rd Generation
4G	4th Generation
AOSE	Agent Oriented Software Engineering
ASG	Academic Support Group
BESA	British Educational Suppliers Association
BYOD	Bring Your Own Device
CAQDAS	Computer Assisted Qualitative Data Analysis Software
BYOE	Bring Your Own Everything
CRB	Criminal Records Bureau
CiCS	Corporate Information and Computing Services
DBS	Disclosure and Barring Service
FE	Further Education
GDP	Gross Domestic Product
GORE	Goal-Oriented Requirement Engineering
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSMA	Global System for Mobile Communications Association
GTP	Graduate Teacher Programme
HCI	Human Computer Interaction
HE	Higher Education
HEA	Higher Education Authority
HEFCE	Higher education funding council for England
HEIs	Higher Educational Institution(s)
HEITS	Higher Education Information Technology Statistics
HESA	Higher Education Statistics Agency
ICT	Information and Communication Technology
ID	Instructional Design
IDC	International Data Corporation
IEEE	Institute of Electrical and Electronics Engineers
IPPR	Institute for Public Policy Research
ISA	Independent Safeguarding Authority
ISD	Instructional Systems Design
JCR	Journal Citation Report

Abbreviation	Description
KAOS	Knowledge Acquisition in Automated Specification or Keep All Objectives Satisfied
KENE	Kaleidoscope European Network of Excellence
LAN	Local Area Network
LMS	Learning Management System(s)
LSE	London School of Economics
LTM	Long-Term Memory
MBA	Master of Business Administration
MDTs	Mobile Device Technolog(ies)
ML	Mobile Learning
MLE	Managed Learning Environment(s)
MMS	Manchester Medical School
MMU	Manchester Metropolitan University
MOBIlearn	A consortium of international organisations and universities promoting the use of MDT in workplace learning
MoLeNET	Mobile Learning Network, a large scale ML project funded by the Learning and Skills Council (LSC) during 2007-2009
MOOCs	Massive Open Online Course(s)
MS	Microsoft
MT	Mobile Tags
MUVEs	Multi-User Virtual Environment(s)
NSS	National Student Survey(s)
NUD*IST	Non Numerical Unstructured Data Indexing Searching & Theorizing
Ofcom	Office of Communications
OOAD	Object-Oriented Analysis and Design
OOSE	Object-Oriented Software Engineering
OpenOME	Open Organization Modelling Environment
OS	Operating System
PC	Personal Computer
PDAs	Personal Digital Assistant(s)
PG	Postgraduate
PGCE	Postgraduate Certificate of Education
QAMs	Quality Assessment Method(s)
QARs	Quality Attribute Requirement(s)
QASs	Quality Attribute Scenario(s)
QAWs	Quality Attribute Workshop(s)
QR	Quick Response
RCP	Rich Client Platform
RE	Requirement Engineering

Abbreviation	Description
SMEs	Small-Medium Enterprise(s)
SMS	Short Message Service
SRHE	Society for Research into Higher Education
SRL	Self-Regulated Learning
TEL	Technology Enhanced Learning
TIS	Technological Innovation System
tPCs	tablet Personal Computer(s)
TV	Television
UCISA	Universities and Colleges Information Systems Association
UC	Ubiquitous Computing
UCTs	Ubiquitous Computing Technolog(ies)
UCL	University College London
UEL	University of East London
UDM	Unified Development Methods
UG	Undergraduate
UK	United Kingdom
UML	Unified Modelling Language
UREC	University Research Ethics Committee
USA	United State of America (also known as US - United State)
VC	Vice Chancellor
VCG	Vice Chancellor's Group
VLE	Virtual Learning Environment(s)
WAN	Wide Area Network
WM	Working Memory
WMTE	Wireless and Mobile Technologies in Education
WoK	Web of Knowledge
WWW	World Wide Web

Chapter 1

It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change.

~ Charles Darwin

The research position

1.1. Frame of reference for the study

The aim of the review of this thesis is to derive models for adoption and integration of Mobile Device Technologies (MDTs) in learning and teaching; proposing new approaches towards sustainable Mobile Learning (ML) practices in UK Higher Education (HE). Techniques and methodologies within Requirement Engineering (RE) and Agent Oriented Software Engineering (AOSE) disciplines have proven useful for requirement analysis of complex agent oriented systems. Elicitation and modelling techniques of RE and AOSE are applied to fully understand current state of the art of ML domain. Requirements for seamlessness in future adoptions and integrations of MDTs in learning and teaching are also determined for the purpose of creating abstract models of the system and improving the efficiency of processes within it.

Specific aims and objectives of the review of this thesis can be summarised as follows:

- To investigate factors relating to the adoption, integration and sustenance of MDTs in learning processes and its impact on the transformation of instructional designs and educational processes, in order to highlight links with achievement of overarching goals of a learning establishment.
- To investigate and critically evaluate previous approaches to the examination of MDT adoption and integrations and the practice of ML.
- To develop models presenting and aligning requirements for sustained and seamless MDT adoption and integration in ML practices with goals, strategies and policies of an institution; through elicitation conducted among stakeholders in education such as students, academics / educators, those in the role of learning support and governance, and IT support personnel etc.
- To consider and explore the application of modelling strategies within RE and AOSE disciplines for highlighting and resolving issues within the domain of ML.

Thus, the study presents 'system-as-is' models, drawing specific attention to how issues within the domain may be contributory to difficulties in achieving overarching goals and strategies of a learning institution, as well as 'system-to-be' models to illustrate how institutional policies and strategies can be aligned with goals for seamless integration of MDT in educational / ML processes. These approaches uniquely employs techniques provided in domain neutral RE and AOSE disciplines for specifying goals and requirements for complex systems; a departure from existing approaches in literature for ML, focused predominantly on evidencing benefits through usage implementations and experimentation.

1.2. Changing face of education

'The only constancy in life is change' is a common saying, now a truism of sorts. The phenomenon is particularly applicable to technological developments. It is also applicable to some extent in educational practices; although it could arguably be contended time and events often stand still with regards to traditional learning systems. Regardless, society changes, and so do all systems within it, including education. There are changes in policies guiding core functions and government / funding reforms are constant threats among others. More recently, changes affecting United Kingdom (UK) educational system have been attributed to technological innovations almost as much as to rising tuition-fees; prompting DeShields et al (2005) to suggest institutions must consider a "*customer-oriented philosophy*" in services delivery (pp. 130).

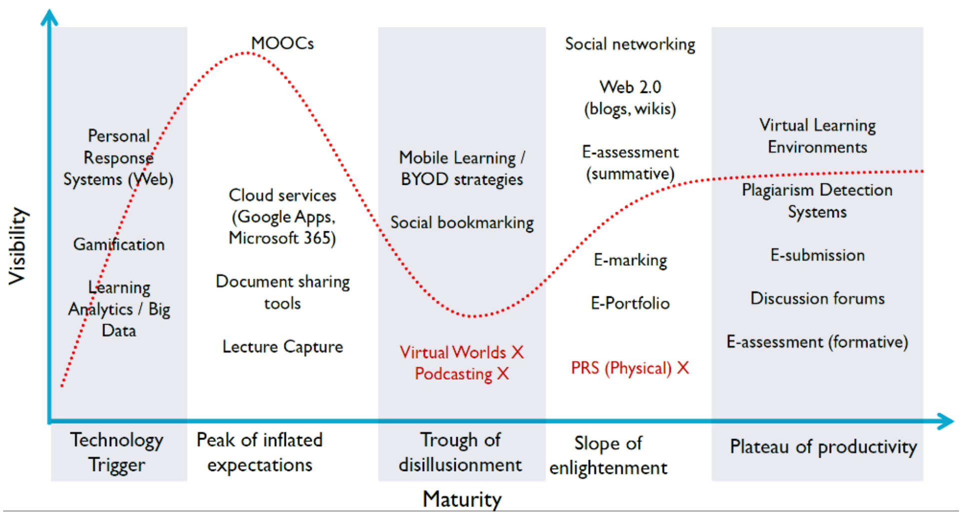


Figure 1.1: TEL hype cycle showing placement of activities in ML (Based on Gartner's hype cycle methodology; cited in Walker & Voce, 2014)

Advances in technological innovations is believed to have resulted in availability of an inordinate amount of "*teaching and learning tools*" which sometimes complicate matters in DeShields et al (2005)'s opinion (pp. 130). The authors also suggest operational costs as well as demand for sophistication and professionalism in learning and teaching have increased significantly. In that sense, while technology itself is constantly changing, it is also acting as an agent of change in education; influencing conditions, policies, behaviours and practices etc., and perhaps not always for the better.

Over the last three decades for example, advances in Mobile Device Technology (MDT) development have been phenomenal. From little more than communication tools used by the select few in the early 70s, handheld but more cumbersome than *mobile*, MDT has become a 'multi-purpose', portable and wearable fully-operational computing equipment. MDT is pervasive and intrusive. Yet, it's been embraced by the society; transforming communication channels and social interactions, fast becoming one of the 'must-have' technologies in this age.

DeShields et al (2005) suggests organisations or businesses risk becoming irrelevant if they fail to respond appropriately to changes. Using Gartner's hype cycle methodology, Walker & Voce (2014) identified ML's progress from findings of UCISA longitudinal study (2001, 2003, 2005, 2008, 2010 and 2012) on Technology Enhanced Learning (TEL) in UK Higher Education (HE). The hype cycle placed ML in the "*trough of disillusionment*", suggesting interest is not as keen as it may have once been within the domain (see Figure 1.1).

Given the changes in communication, consumer behaviour, social interactions and others resulting from MDT integration in other sectors within the society, expecting a similar trend in Higher Educational Institutions (HEIs) is perhaps understandable. In the last decade alone, academic researchers in HE believing in the potential benefits of ML have made several attempts to move it along the hype cycle slope. It is conceivable the express objective is to locate ML within the realms of enlightenment, and ideally in the "*plateau of productivity*", where it is assumed transformative impact in learning can be clearly seen. ML's location in the TEL hype cycle in Figure 1.1 may be an indication HEIs are struggling to respond as may be expected.

Therefore, this research seeks to understand these changing dynamics from the point of view of the opinions and practices of stakeholders within the domain. A fundamental question for the review of this thesis is how HEIs are responding to accommodate technological innovations in MDT. Secondary but equally important is to establish the rate at which education should evolve if it is to take full advantage of opportunities presented by advances in MDT proactively. Finally, key challenges for the future, HEIs and stakeholders within the educational community are identified and some likely solutions proposed.

From mobile telephones to PDAs (Personal Digital Assistants) and later smartphones with touch screen technologies; the blanket term ‘mobile device’ is now used to include wearables, tablet PCs and e-book readers; even including portable laptops, notebooks or netbooks (ABIresearch, n.d.; O’Malley, Vavoula et al, 2003; Brown, 2005; cited in Brill & Park, 2008; Attewell et al, 2009). Common characteristics of devices may include portability and / or wear-ability, multi-device convergence affordability e.g. audio, video, camera etc., communication channels e.g. voice services, GPS and location / context-aware services, Short Message Service (SMS) or text messaging service etc., Bluetooth and / or Wireless (or WiFi) connectivity and other features and affordances.

In this thesis, Mobile Device Technology or MDT include mobile phones, smartphones, PDAs, tablet PCs, e-book readers and certain portable notebooks, netbooks, laptops or similar; characterised by features capable of enabling mobility in learning, such as WiFi or other connectivity features (Ogata et al, 2008; Liu et al, Peng et al, 2009; Beasley & Conway, 2011). The rationale behind the expansive definition originates from the fundamental assumption mobility could be a key differentiating factor between other learning processes and those involving the use of MDT.

This position is supported by recent understandings in the in the domain. For example, Bring Your Own Device (BYOD) considerations now generally include variations of all these technologies (Dahlstrom & diFilipo, Struthers & Lee, 2013;

JISC, 2014). BYOD has recently become popular, in part to avoid incurring the unnecessary cost of MDT provision and partly in recognition of preferential issues for technology. MDT categorisation may also influence definitions proposed for ML and the positioning of MDT in an ML and / or learning process, suggesting an understanding on MDT specification is considered quite important for clarity in conceptual understanding of ML and for concepts expounded in this thesis. More evidences supporting the expansive definition may become clearer in subsequent chapters.

In the last decade, MDT has been assimilated / appropriated into many processes with mixed results e.g. banking, tourism, entertainment, GPS / location aware services, use of SMS text reminders / prompts in health and other services / sectors (UCLH & Azzurri, 2013). SMS uses are also common in learning administration with popularity growing at all levels: Primary, Secondary, Further and Higher Education as well as workplace learning (Nie, 2006; Ally, 2009; Hylén, 2012). The review of this thesis is primarily focused on HEIs, with occasional reference to findings of relevance in other contexts for in-depth understanding.

1.3. Education and Mobile Device Technology (MDT)

The relationship between MDT, ML and education is puzzling but perhaps not surprising. While MDT as a tool of choice definitely has a pronounced presence in the communities, its use in learning in a formal sense and / or in ML processes is believed to be in decline (see Figure 1.1; Walker & Voce, 2014). Arguably, websites, online learning platforms, Managed Learning Environments (MLE) and / or VLEs etc., increasingly have optimised or responsive content; some of which are MDT-accessible. MDT has also proven quite useful in educational administrations; primarily for SMS text reminders, prompts or information delivery purposes as mentioned earlier (Nie, 2006; Hylén, 2012).

Learning institutions are also responding to increasing demand for device support and robust connectivity for MDTs on campus (UCISA, 2011), perhaps contributing to the notion potential transformation to learning is of greater impact in informal learning; students using their devices when allowed to, in support of their formal learning activities (Clough et al, 2007; Rajasingham, 2010; Andersen, 2011; Abdullah et al, 2013). However, fully-fledged integration in a manner contributing to the achievement of learning objectives is decidedly few and far between (GSMA, 2011).

A study conducted at LSE in 2013 found only 14% of 1006 students (142) admit tutors use MDT in "*an engaged and rich way*" while a further 7% (67) "*benefitted from an integrated approach*" i.e. facilitation of teaching and learning activities (Grussendorf, 2013). This state of affairs seem common in UK HEIs. A similar survey in Northampton University for instance suggested ML is "*developing*", adding benefits are still unknown (Howe et al, 2013, pp. 6). EDUCAUSE and other studies found while using MDT is on the agenda for teaching and learning, "*guidance or institutional support*" or usage policies for both staff and students lacking (Dahlstrom & diFilipo, 2013, pp. 24; Walker et al, 2013).

High visibility of MDT among students is seen as a strong driver. MDT is no longer for the select few as they become increasingly low cost to acquire and use; connectivity provision increasingly robust, free and secure in public spaces. In developed countries, many students own at least one device (Hopkins et al, 2013) and ownership is growing in less developed countries (Mulligan, 2013). Recent surveys conducted in UK HEIs reported some students own an entire range, from mobile handsets to tablet PCs and variations of models in-between (University of Sheffield, 2011).

Perhaps recognising this, many HEIs as well as business organisations are in a rush to implement BYOD schemes and focus on providing support for devices as well as access to robust wireless networks (Walker et al, 2013). Some issue free tablet PCs to students along with free e-books and study materials pre-loaded. University of East London (UEL) is one example, planning to issue Samsung devices pre-loaded with core texts to some students in 2014/15 academic year. Southampton, Staffordshire, Glasgow's Adam Smith Business School, Queen Mary and University College London already offer iPads or Android tablets on selected programmes.

Yet, placement in formal learning remains questionable. UCISA TEL survey found only 19% of 98 respondent institution have an ML strategy; uses of MDT generally described as "*mobile learning for course materials, lecture capture, quizzes*" (Walker et al, 2013, pp. 61, 80). A member of the board of one of UK HEIs admit the expectation regarding provision of tablets to students is for students and academics to use "a*s they see fit*" to enhance teaching and learning; with no formal strategies beyond the provision. Carroll et al (2002) believe the end result of such approaches may be uncertain, encouraging either acceptance or rejection by students, educators and / or other stakeholders in education.

1.3.1. The history of MDTs

The first handheld mobile device emerged in 1973, Japan the first to commercialise an MDT network in 1979. Introduction of 2G standards in 1991 led to the launch of the first of Europe's GSM 2G networks in Finland. This began an era of SMS messaging and the manufacture of touch screen devices, PDAs and smartphones. An Oracle study in 2011 found almost 70% of consumers surveyed use smartphones in place of digital cameras, iPod / MP3 players and GPS systems (Oracle, 2011, pp. 4). Screen sizes became less of an issue as devices with larger screens began making their way into the market and educational processes.

A 1981 article titled "*Portents of Future Learning*" featured in **New computers**, a computing magazine, predicted some of the scenarios now unfolding. At the time, e-books and the first commercially available portable device have emerged and the author reported Motorola was also being pushed to develop wireless communication products "*small enough to use anywhere and at anytime*". Considering children's ability to use microcomputers more easily, the author added some schools may soon provide "*compact electronic learning aids that can be toted to and from school like a lunch box*" (TIME, 1981, pp. 77).

Establishment of wireless standards in the mid-1990s was a notable game changer, making mass learning on mobile devices even more feasible. Wireless connectivity coupled with increasingly miniaturised powerful computing processors, large data storage capacities and multimedia platforms may be credited for the availability of increasingly sophisticated devices with potential educational affordance features (Sheridan, 2013). Invariably, 1990s saw the start of e-learning and / or b-learning (blended learning); the former now more closely associated with learning delivered online. As mobile devices make their way into educational processes, the terms *hand-held learning*, *mobile learning* or *m-learning* began to appear in research publications.

In November 2001, Apple released the first generation of iPod devices, and in 2007, the first generation of iPhones; starting a trend in the development of MDT "app", a term used for purpose-built applications on mobile devices. Apple's iTunes, Google's Android market and more recently, Microsoft's Windows Store provided online platforms for MDT "app" tools, enabling easy access to a growing array of apps. The Oracle study found only 37% of those surveyed indicated they have never downloaded an app to their mobile device, with 4% unsure by 2011 (Oracle, 2011).

Whether accidental or by design, some believe app evolution has influenced software applications design, implementation and marketing strategies considerably (Garg, Lehman, 2013). Apps have also given rise to a variety of 'portable' learning systems delivering powerful, innovative and engaging content to learners' mobile devices. It is now a commonly acceptable term for small-medium purpose-built applications capable of performing single tasks on smartphones, tablets, laptops as well as online portals and desktop PCs. It is however believed the development present several challenges relating to cross platform integration and choice of development tools (Ali, 2013).

MDTs have changed the way we communicate with each other, perhaps not always for the better (Castells et al, 2007; Roberts, 2010). New vocabularies creep into speech patterns, many of which are 'on the spot' creations propagated at viral speeds as 'text-speak' become the norm. Behavioural patterns have been transformed; rudeness and intrusion fast becoming the order of the day (Roberts, 2010). The use of MDTs in public places like the cinema, conferences and even some lecture halls are considered a nuisance, largely because there is no letting up on attendees conveniently forgetting to turn off their mobile device or silence their ring tones.

The necessity to make messages short and to the point, popularised by the creation of Twitter in 2006, have also been attributed to originate from device-affordance culture; the conceptual remit for Twitter was reportedly founded on "*the idea of an individual using an SMS service to communicate with a small group*". This is perhaps also not unconnected to limitations imposed very early on by small screen sizes and text input systems on devices. Summing of scenarios and events into small bite-sizes have become entrenched; sometimes called 'tweets': a term also popularised by Twitter ('Twitter', 2014).

This particular culture is also believed to have yielded mixed results. While on the one hand the ability to summarise and synthesise information is being developed, communication, spelling and grammatical abilities are negatively impacted. The intrusion and demand for immediate attention / response to text messages is also considered distractions on learners' ability to concentrate as necessary at times (Stewart, 2013).

MDTs may also be acting as a catalytic symptom of age and class divide. We Are Apps report suggested while technology acceptance is growing among those age 65 years and over, younger adults are more likely to own or use MDTs (We Are Apps, 2013). A BBC report in 2010 concurred, suggesting fear is the main barrier. In spite of increasing usability of computing equipment and MDTs, reduced cost and considerable benefits to lifestyle, mention of the words 'computer' or 'technology' immediately puts elderly people off (Wakefield, 2010). The BBC report however suggested there are indications devices with touch screen technology is proving increasingly popular.

1.4. A roadmap for Mobile Learning (ML)

As may be deduced from previous sections, MDTs have not been spared from educational appropriation attempts, by no means (Walker et al, 2013). In a pattern now considered *modus operandi* of sorts, MDT has had its fair share as may have been illustrated by the TEL hype cycle in Figure 1.1. Members of the educational community are likely familiar with discourses on ill-considered enthusiasm accompanying advents of innovative technologies. Whether deserved or not, early adopters get laudable praise and derision almost in equal measure.

Arguably, early promises of a technology are often overshadowed by the “hype” accompanying technological adoption in most cases but perhaps particularly true for learning establishments. Some technological systems are eventually found to be either badly managed, unfit for purpose and / or mal-aligned with the broader learning and teaching strategies of the organisation as noted by Gartner (2008), deriving the hype cycle methodology illustration in Figure 1.2.

The graphical representation of the phases in Figure 1.2 show early adoption following rapidly after a trigger period. This phase is characterised by “inflated expectations” and lack of conceptual understanding, sometimes leading to ill-judged experimentations. The process continues through periods of disillusionment, and a much lengthier period of enlightenment and productivity. Figures 1.1 show ML progression is proving true to this form, currently believed to be in disillusionment phase.

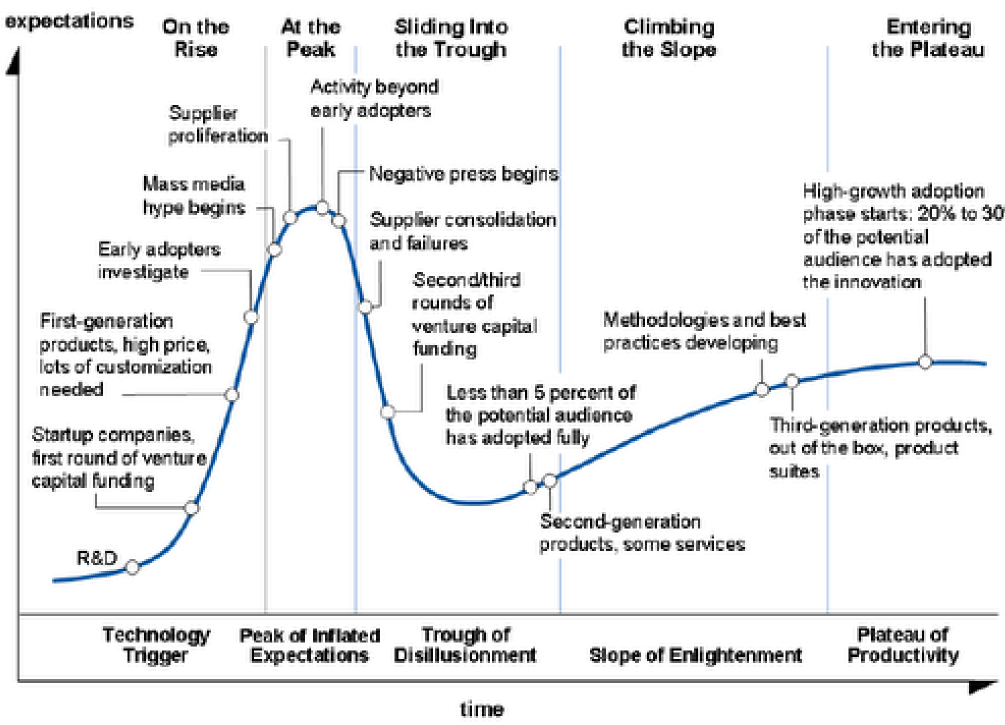


Figure 1.2: Hype cycle of technology’s life cycle (Gartner; cited in bimeanalytics.com, n.d.)

Loose conceptual interpretation was one of the major issues identified in literature quite early on, symptomatic it is believed, of the lack of clarity surrounding the concept (Frohberg et al, Peng et al, 2009). Attempts to narrow the field by specifying characteristics helped but many of these are subjective and open to interpretation. For example, Liu et al (2009) suggested ML process should exhibit characteristics including permanency, accessibility, immediacy, interactivity, situation, calmness, adaptability, seamlessness as well as immersion. The problem is many of these attributes could also be applicable to an e-learning process (Yi et al, 2009).

Regardless, ML has gained some grounds as a discipline in recent years. There are now several conferences and journals dedicated to ML running periodically, with publications spanning over a decade. Early trial attempts may have suffered from device limitation issues, ranging from small device screen and poor processing capabilities to poor performances due to less than robust network platforms with little or no connectivity to external systems (Clough et al, Litchfield et al, 2007; Kim, Wang et al, 2009). Many of these issues have either been eradicated or subsumed with others as new advancements emerge.

Frohberg et al (2009) found and categorised 102 ML instantiations between 1996 and 2007, many of which have since been discontinued or stalled. Others including ESCalate from the University of Bristol presented several more. ESCalate titled its publication "*Making mobile learning work …*" perhaps summing up the general feeling about the state of the art (ESCalate, 2011). A survey conducted in Northampton University between December 2013 and January 2014 found ML is still in its infancy within the university, adding "*staff and students are often unaware of opportunities and may benefit from examples of good practice*" (Howe et al, 2014, pp. 6).

This may indicate there is a disconnection between theoretical understanding, ML activities and continuing practice. Introducing ESCalate publication, Traxler (2011) suggested case study of activities may help influence "*policy and practice*" (pp. 10). Attewell et al (2009)'s report of the MoLeNET project also found some evidence to support the need for expert practitioners with experience in using MDT in learning. Years earlier, Engelbrecht (2003) cautioned there must be a distinct move from mere replication of traditional classroom with technological support to exemplar practices in "*online instructional designs and the creation of online learning communities*" (pp. 39).

The latter, it is believed, has the benefit of considered processes based on pedagogical underpinning and empirical research findings.

1.4.1. Motivating today's learners?

How do adults learn? Or perhaps more precisely: Is adult learning any different in today's technological age than it was in previous ages? Age-old questions that will likely be forever pondered upon in educational cycles. The answer may not be simple and can be extensive in spite of years of research (Fry et al, 2008). This section will attempt a brief discourse on the subject which will be further developed in subsequent sections and chapters within this thesis.

Years ago, Kolb (1984) supplied a theory considered revolutionary at the time and since, suggesting learning can be modelled in a cycle comprising of four learning abilities and contexts: concrete experience, reflective observation, abstract conceptualisation and active experimentation. Kolb added learning should be characterised by "doing" or experiencing. This concept has since been given the term experiential learning, commonly believed to be especially useful in adult education. It has also been found to be particularly relevant in ML processes; researchers suggesting educational affordances of MDTs make them especially suitable for facilitating experiential learning processes (Lai et al, 2007; Dyson et al, 2009; Genossar et al, 2008; cited in Daher, 2010).

A second idea, perhaps also considered profound when originally proposed and since concern taxonomies proposed by Bloom et al (1956; cited in "Bloom's taxonomy", 2014) which suggest there are three domains of learning: cognitive (concerned with knowledge and intellectual skills), psychomotor (relating to physical skills) and affective (relating to feelings and attitudes). This school of thought may offer some basis for those suggesting there must be considerations for students' preference for deep, surface or strategic approaches to learning.

Students who prefer a deep learning approach are believed to enjoy "*learning for its own sake*" (McKimm, 2002, pp. 4). Deep learning involves critical thinking and analysis of concepts and ideas which can lead to understanding and problem solving (Case, 2008; HEA, 2011). Other students may have preference for the surface approach, seeing studying only as a means to an end. Students adopting the surface approach will accept new facts / ideas without critical analysis or questioning and are heavily reliant on rote learning. Entwistle (1998; cited in McKimm, 2002) added strategic learning as a later categorisation, concerning those with preference for passing and achieving highly but without real interest in the learning itself.

Abstraction of meaning and understanding reality are indications of deep approaches to learning; while increase in knowledge, memorising and acquisition of procedures are considered indications of surface approaches (Biggs, 1987; cited in McKimm, 2002). Strategic approaches are typified by consistently focussed effort into studying, seeking out the right conditions for success, managing time well, awareness of assessment requirements and focusing on satisfying the requirements, and working to satisfy perception of tutor's preference (McKimm, 2002, pp. 5).

Guiding students through Bloom's domains of learning and / or motivating them to "deep" rather than "surface" or "strategic" learning is likely the ultimate goal of any teaching and learning strategy (Bloom et al, 1956; cited in "Bloom's taxonomy", 2014; Kukulska-Hulme, 2010). Achieving this objective is another matter entirely. VanderArk & Schneider (2012) maintain ML "*apps and game-based learning*" can enable "*possibilities for regular student application of critical thinking and problem solving skills*", thus achieving deep learning (pp. 16).

Scaffolding learning is another consideration for motivating learners to deep learning; in a gradual process which provide learners with support until they "*gain mastery of the task*", at which time the scaffolding is removed (Wood et al, 1976; cited in Tharp & Gallimor, 1988; cited in Abdullah et al, 2013). MDT is believed to be particularly useful in enabling scaffolds in learning processes. VanderArk & Schneider (2012) suggest the "*critical thinking and problem solving skills*" mentioned earlier can be done in a scaffold ML process "*by allowing students to collaborate seamlessly with peers and teachers for ongoing feedback*" (pp. 16).

Context-aware information from web-based response systems have been utilised successfully in ML implementations with students to facilitate learning with scaffolds (e.g. Chen et al, 2003; Chen et al, 2008; Wishart, 2013; Abdullah et al, 2013). However, Valcke (2011) suggest MDT may be a barrier to deep learning, stating most implementations reduce them into tools for distribution of learning content for the most part. Liu et al (2007; cited in Taylor, 2010) agree, adding there is a neglect for context considerations "*as an interacting factor*", specifically "*what aspects of the context are necessary to enable deep learners to engage effectively*" in some ML implementations (pp. 33).

Lyons (2010) also agree, illustrating the problem in an ML zoo visit scenario, facilitated through MDT affordances and connectivity capabilities such as GPS / context and / or other location-aware sensors and WiFi and data connection systems. In such scenarios, Lyons (2010) maintain, learning outcomes will be "*more affective than educational*", with "*opportunities to engage in deep reflection*" uncertain or "*rare*" (pp. 35). Among others, these are important considerations for the review of this thesis in order to establish the placement of MDT in educational processes. In Section 5.2, some of the theories considered in this section will be explored in more details as relating to HE and its students in particular.

1.4.2. MDT ownership among HE students

Reports of research studies conducted in various universities would suggest MDT ownership is increasing among students each year. University of Northampton surveyed 444 respondents in 2012/13 and 2013/14. For comparison, results for 2012/13 are also shown as follows:

- 93.5% students and 6.5% staff (**2012/13:** 63% students; 37% staff).
- 97.3% of survey respondents currently own or regularly use a mobile device capable of connecting to the Internet (e.g. a smartphone or tablet) (**2012/13:** 95.8%). Of these,
    - *93.2% own a smartphone (**2012/13:** 83.4%)*
    - *54.1% own a tablet device (**2012/12:** 37.5%)*
- 92.5% own a laptop (**2012/12:** 88.2%)
- 18.3% are planning to purchase a tablet in the next 6 months (**2012/12:** 23.5%)

- 4% are planning to purchase a laptop in the next six months (**2012/12:** 3.2%)

Source: *Howe et al (University of Northampton), 2014*

London School of Economics surveyed 1130 students with 1070 completing in 2013 and found the following:

- 99% own a laptop (53% windows, 45% Apple Mac OS)
- 91% own a mobile phone with internet connectivity; only 8% of respondents own phones without connectivity (47% iPhone, 33% Android, 8% Blackberry).
- 36% of respondents own a tablet and 36% other.
- 1% have no laptop or mobile phone and 64% have no tablets.
- Most of the students own a laptop as well as a mobile phone; 377 (35%) of these also owning a tablet (83% of which have Apple iOS – proprietary OS in Apple devices).

Source: *Grussendorf (LSE), 2013*

University of Sheffield received 2180 responses, 9% of the university's student population, to a study conducted in 2011. Male respondents make up 46% of the total; 54% were female. Only 81% of students between 18-24 years old completed the survey. This age group reportedly account for 89% of the university's student population. The following are the results:

- 98.94% (2157) own a mobile phone; and 56% own a smartphone.
- 89.91% (1960) own a laptop; 11.97% (261) own a netbook.
- 6.65% (145) own a tablet / e-book reader
- Less than 1% (9) do not own a mobile phone.
- 5 students own all equipment (smartphone, laptop, netbook, tablet/e-reader etc.).
- Just over 1% (26) owned all equipment except a netbook and 5 own all equipment except a laptop.

Source: *CiCS – (University of Sheffield), 2013*

Manchester Metropolitan University (MMU) interviewed 100 students about their use of technologies in general on campus between January-March 2011. The following are some of their findings:

- 98 of the 100 students interviewed brought their mobile phones with them to the interview; 45 also brought a laptop or netbook.
- The following are the students' modes of accessing learning:
    - ***At the university:*** *mobiles: 79 / laptop: 31 / desktop: 40*
    - ***From home:*** *mobiles: 81 / laptop: 43 / desktop: 21*

- *From work:* mobiles: 32 / laptop: 4 / desktop: 1
- ***From train / bus:*** *mobiles: 67 / laptop: 13 / desktop: n/a*
- ***From café / pub:*** *mobiles: 57 / laptop: 15 / desktop: n/a*

OMbeil's report in June 2010 (*The Rise and Development of the Smartphone*, cited in GSMA, 2011) provided the following data:

- University of Edinburgh surveyed about 2000: 49% had smartphones (Apple 35%, Nokia 25% and Blackberry 17%).
- Trinity College Dublin conducted a survey of about 2250: 40% had internet enable phones.
- Kent University surveyed 270: 78% had wireless access, 68% collected email via phone.

Thus, it is no longer a question of availability. MDT's presence within the walls and bounds of educational establishment is becoming the norm, just as it is in the society. Consequently, GSMA (2011) report suggest, "*as students become increasingly mobile, it is likely institutions will have to adapt to accommodate this demand*" (2011, pp. 24; Walker et al, 2013). The suggestion may be evidenced up to a point in HEIs' current responses; many making increasing efforts to improve connectivity and network infrastructures around campus (UCISA, 2011).

1.4.3. Can MDT cure short-comings in learning?

This is arguably another question that may be difficult to answer. An attempt will be made by presenting a few case study examples from ESCalate and UCISA's Good Practice Guide for ML to establish a reference point for a discourse on the matter. The first of these is a flood disaster simulation by academics from the University of Aberdeen with final year undergraduates, reported in ESCalate (Cornelius et al, 2011, pp. 13-17). The simulation occurred over a 3-day period, involving the use of SMS text messaging to teach about decision making in a flood disaster scenario.

Text messages to students prompted for decisions, followed by further responses and prompts using a decision tree database system. A tutor played the role of civil defence representative while students played the roles of utilities managers. In general, there were positive reactions from students but some suggest more information should be provided through the text message responses / prompts from the system. The facilitator noted longer messages will require ‘newer phones’ with adequate screen sizes and a complex decision tree system a substantial design effort.

A second example, facilitated by a member of the Learning Development Center at City University, London was also reported in ESCalate. It involved a group of postgraduate students using GPS to gather data for decision making activities on residential field trips, using their mobile devices. The study considered problems that may arise from students using own devices as opposed to borrowing them from the institution, suggesting students may prefer the former. A key recommendation was the need for loose structures allowing for flexibility and creativity on the part of the students (Beddall-Hill, 2011).

The third example is from a publication by the Academic Support Group (ASG) of UCISA’s Digital Skills and Development Group. Reported to be the “*first and largest iPad*” ML case study ever implemented in UK HE, it could quite simply be one of the best illustrations of how ML can be differentiated from other types of learning as explored later in Section 2.4.2. The study occurred during the clinical phases in years 3-5 of 450 students in Manchester Medical School (MMS). The students were distributed across England in 15 teaching hospitals, which meant they were geographically separated; and there were also inconsistencies reported in terms of “*access to reliable technology and educational resources*” (Mooney et al, 2014, pp. 18).

Facilitators maintained the only workable solution in this case was ML, suggesting it allowed a “*more cohesive curriculum delivery with such a distributed student community … from a centrally hosted platform*” (Mooney et al, 2014, pp. 18). The tutors developed "*over 150 purpose built*" ML learning content for not only iPads but also accessible on other devices, for example, those on Windows OS. Challenges concerned the cost of issuing iPads to the students and the amount of time needed for configuration by IT service staff (pp. 19).

These examples may perhaps illustrate the thinking process required for ML to be, not only viable and sustainable, but also *transformative*. The amount of effort and considerations required to implement and administer such scenarios was noted by many of the facilitators. This could be prohibitive if efforts required are excessive (Beer, n.d.). There are also requirements for some innovative thought process to address challenges. In addition, it may be important to note the first two examples was focused on role playing and decision making, although the second gathered data from external sources rather than responding to an online system.

The third was primarily a logistical solution without any evidence other educational affordances on the device was used in the process besides mobility, accessibility, connectivity and ubiquity of the learning (Woodill, 2010, pp. 53; cited in Belshaw, 2010; pp. 10). Therefore, a necessary question may be whether MDT is applicable in every discipline and every learning scenario. Would the same process be replicable in a computer programming, engineering, history, mathematics or fashion designing etc., in the same way and with the same degree of success?

It is clearly impossible to provide applicable case study for every learning scenario instance. A more sustainable approach may require a re-engineered thinking process across all domains within teaching and learning that is based on the need to transform the established status quo. For example, 'What is learning?' is another question that may be added to such age-old questions as have been asked in this chapter. Conceivably, many of these are perhaps not asked often enough anymore; the assumption answers are already known. Thus, "What is learning?" can only be a start that should be expanded to reflect the problem more specifically i.e. What are the requirements for learning in an abundantly available technological age and what part does MDT play?

That this questions require asking again and again is a view supported by a research study during the early years of ML. Carroll et al (2002), considering requirements for ICT (Information and Communication Technology) in learning which included MDTs, as was the practice at the time, suggested there was a need to ascertain requirements for such processes first. The authors criticised the top-down approach of evaluating results through appropriation and replication of traditional processes, even when ‘enhanced’ by technology. They conclude this method has two likely end results: integration or “*disappropriation*”; suggesting a more useful approach will be one that establishes an “*understanding of young people’s use of mobile technologies*” first before integration in learning (pp. 2).

Over a decade later, there’s an acknowledgement the authors may be right in a JISC report (2007; cited in Kukulska-Hulme, 2010) suggesting learners are “*under-researched and imperfectly understood … in a digital age*”, adding there is “*a mismatch between the expectations of academic staff and the study habits of learners*” (pp. 7). To find likely answer(s) to the question(s) asked in this chapter therefore, it is argued more rigorous research is needed; one that is able to determine the precise requirements for achieving all the desirable goals.

1.4.4. The challenge for education

It may perhaps be quite clear now education have probably never faced a greater set of challenges. MDT for instance is a technology that has undergone so many rapid feature changes in the last decade alone. The response within educational community seem to occupy two opposing extremes: enthusiasm and periods of activities involving trials with learners or dismissal / indifference (see Figure 1.1). Constant feature changes add another level of complication for sustained usage (Clough et al, Lai et al, 2007; Kim, Peng et al, Taylor, 2009). Learning establishment often have good intentions and try to ensure they keep up to date with the latest emerging technology. However, no sooner has one been appropriated before it becomes obsolete and unsupported by manufacturers.

Recently, MOOCs have taken off in a big way, offering learning content and instructions for various further and higher educational programmes, but without degree accreditation or HE qualifications. The impact of this as well as UK government’s education reforms on student enrolments are yet to be seen. In order to remain competitive and at the same time, provide students with skills that are current and relevant in today’s employment market, it would seem "*universities will increasingly have to demonstrate more clearly to students what* *they can offer that these online alternatives cannot*" (IPPR, 2013, pp. 32).

The conceptual understanding of ML in learning is another major challenge. The precise characteristics of an ML process is uncertain, resulting in difficulties to evaluate their effectiveness. Should access to learning content be considered an ML process and if so, where or when is the learning occurring? Should the term be applied to processes involving what may be considered "deeper cognitive learning" achieved through MDTs only? How about when used in learning administration; new learning resource alert, schedule changes, upcoming events etc.? Similar questions have been topics of many discussions on the issue in recent past; leading to the suggestion it may be time to ignore these issues and focus on moving the agenda forward (Traxler, 2005, cited in Winters, 2006, pp. 5; Duncan-Howell & Lee, Lee & Chan, Traxler, 2007; Dyson et al, Peng et al, 2009).

Difficulties in quantifying benefits or evaluating ML processes have not been helpful; attributed in part to lack of consensus in conceptual understanding (Frohberg et al, 2009). Wang (2009) went further to suggest best practices are yet to be defined, adding more is needed to identify precise characteristics and strengths of ML. There are other concerns and challenges. For instance, while it may be accepted mobile devices could enable flexibility in learning, additional complications and potential disruptions in classroom management is proving insurmountable. In questionable usage circumstances, the response in some institutions is an outright ban for their use.

This is most common in Schools and Further Education (FE) colleges; reasons given including combatting bullying, helping students concentrate better, encouraging better behaviour / obedience to rules etc. (Gray, The Guardian, 2011; Barkham & Moss, 2012). Government ministers sometimes wade into the debate, calling for legislations and bans to be upheld, at least in schools (GSMA, 2011, pp. 12). However, there are signs opinions are changing (GSMA, 2011, pp. 12). In some UK schools, pockets of protests have been reported recently against bans; students in Seaford Head School in East Sussex for example raising a petition against mobile phone ban, albeit only "*at break time and lunch time*" earlier this year (Eastbourne Herald, 2014).

Some HE students have also reported tutors prevent them from using devices in lecture halls assumed to result from lack of policies guiding their use. A survey commissioned by Manchester Metropolitan University Student Union (MMUnion) to determine preference following complaints from students "*unhappy that they were being asked not to use and / or turn off their mobiles during lectures*" is one example. Noting the problem is not "*limited to MMU as was demonstrated in the Times Higher Education*" in the week preceding the report, their findings suggested 23% think devices should be banned during lectures, 52% want the tutor to decide and 25% want MDT use encouraged (MMUnion, n.d.).

The GSMA report mentioned earlier suggests the problem may have something to do with wireless network infrastructure provisions. A BESA research found 75% of primary and 92% of secondary schools have wireless networks. However, the bandwidth demand is assumed to be "*more than twice*" what was available at the time (GSMA, 2011, pp. 12). The possibility of some students using devices to gain unfair advantage in assessment was another issue highlighted (Moallem 2005; Clough et al, 2007).

Table 1.1: Technology in the UK Higher Education Sector

Technology	Penetration
Virtual Learning Environments:	100%
– Blackboard Classic (main VLE)	25%
– Moodle (main VLE)	23%
Centrally supported technology	
– e-Submission	89%
– e-Assessment	80%
– e-Portfolio	72%
– Social networking	33%

(Source: GSMA, 2011)

However, despite all these issues, institutions and learning providers expend a considerable part of their annual budget providing robust wireless connectivity and support for MDTs. The 2010 HEITS study reported 81% of HEI respondents to the survey provide connectivity via eduroam and 78% via own wireless or WiFi infrastructures. Many have also implemented BYOD schemes. The study found 68% provide support for students' own laptops, 57% for a variety of mobile devices and smartphones and 63% for iPads / tablet PCs (UCISA, 2011).

Given these scenarios, HEI governance often argue enough is already being done while accepting there are always room for improvement. E-learning provisions such as Learning Management Systems (LMS) or Virtual Learning Environments (VLE) are often cited in addition to wireless connectivity and BYOD support. UCISA's 2010 survey of Technology Enhanced Learning (TEL) for HE and Kable's Education ICT in the Public Sector (cited in GSMA, 2011) found some evidence supporting some degree of penetration of those systems (see Table 1.1).

A survey by Blackboard however found "*only 14% of FE and HE students are provided with services delivered to their mobile devices … customised for a mobile phone*" and only 8% send updates via text messages (cited in GSMA, 2011). McLoughlin and Lee (2008) argue LMS or VLE may not be adequate to support the requirements of today's learners. The authors added these systems merely imitate … '*models, conforming to a "student-as-information consumer""*. Carroll et al (2002) agree, maintaining infrastructure provision alone cannot equate considered TEL integration approach (Tenekeci, 2011).

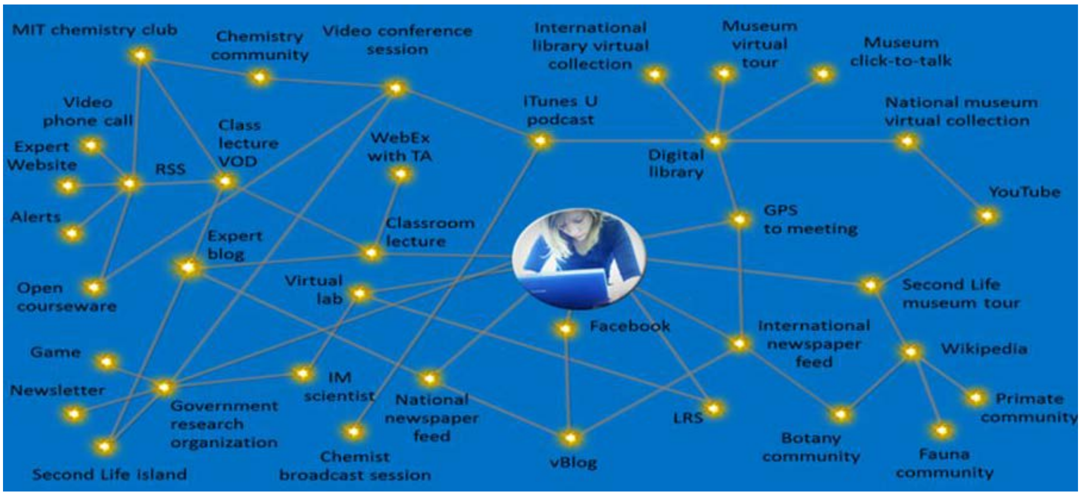


Figure 1.3: Learning ecosystem (Immel, 2014)

Changing the status quo will not be easy as the previous decade of efforts to integrate MDT in learning may have shown. This may also be clear as interest wanes, illustrated in the hype cycle in Figure 1.1. However, the greatest challenge for education may be the increasingly obvious realisation not addressing the issues in a more considered manner may not be an option.

Partly because MDT availability and ownership among students is growing as outlined in Section 1.3.2, as a result of changing roles, students becoming more aware of their status as customers, and also because ignoring problems is probably not a lasting resolution, HEIs and other educational establishments may find changing in some form or the other inevitable (Beer, Powell, n.d.).

1.5. Old story, new approach

Learners before the 21st century may find some of today's classrooms unrecognisable in many ways. Figure 1.3 shows a learning ecosystem copyrighted by Imagine Education and featured by Tracy Immel (2014; cited on Anthony Salcito's blog). The ecosystem conceptualised the complex network of available technologies and learning systems characterising some learning environments.

A group of students in Brentford School for Girls (UK) recently asked some their peers to design their ideal classroom space. Interestingly, in most of the designs proposed, tutor's placement in the classroom was not so obvious or prominent. Supported by NEXT.cc[1], the students designed spaces unlike any of the classrooms they are very likely used to, centering around small group collaborations; some located in unusual areas like gardens, foyer etc (NEXT.cc, n.d.)

Needless to say, such environments may require new learning paradigms, and a radical thought process. Tutors, learners and members of the educational community may also require new sets of skills to thrive in such environments (see Figure 1.3 and 6.1). The expectations MDT could be part of the solution remain unrealised to a large extent, perhaps leading Petterson & Vogel (2012) to argue the desired end result of many of the MDT integration attempts have not been translated into practice. The authors suggest reusability and interoperability in ML systems may be the answer.

Thus, MDTs may be increasingly multi-functional, convergence devices, but

[1] Provider of design learning activities

opinions are still divided on their precise role in learning. Traxler (2012) claim it has been demonstrated ML "*can extend, enhance, enrich, challenge and disrupt existing ideas and assumptions about learning*" (pp. 7). However, while students use MDTs to support informal learning, it is unclear what impact this is having on the formal process. Also and by all accounts, those in the educational community seem unable to see those benefits or unsure how to integrate MDTs into formalised practice (Kukulska-Hulme, 2009; Oracle, 2011; Cruz et al; Petterson & Vogel; Traxler, 2012). Regardless, the perceived inertia or decline in interests (see Figure 1.1) may offer more tangible support for the need for a different approach (Petterson & Vogel, 2012).

Considering these issues, Rajasingham (2010; cited in Petterson & Vogel, 2012) agreed a different approach is needed, suggesting solutions may include "*a standard set of tools, a theoretical framework, multiplatform adaptability, sustainability, integration and course / instructional design*", to which Petterson & Vogel (2012) added interoperability, suggesting "*proven business models*" are still lacking (pp. 306). Rajasingham (2010) believe it is yet to be decided if ML can be a "*sustainable, pedagogically sound real learning … relevant*" in all subject disciplines, styles of learning, contexts, cultures etc (pp. 8). The author propose ML as a subset of e-learning to move the agenda forward. In this study, it is suggested there is a need to determine the requirements for the effective usage of MDTs from an organisational perspective using methodologies such as Requirement Engineering (RE).

RE is a domain neutral discipline, offering techniques capable of providing insights into problems and issues plaguing a system (Berenbach et al, 2009). The techniques are particularly suitable for use with complex and interconnecting systems such as ML; aiding in specifying goals and requirements for that system. They can also be used to align teaching and learning practice / strategies with the overall goals and strategies of learning establishments.

1.5.1. Engineering current reality

Easterbrook (2004) defines Requirement Engineering (RE) as "a set of activities concerned with identifying and communicating the purpose of a software-intensive system" (pp. 7). Easterbrook (2004) added RE "provides a framework for understanding the purpose of a system and the contexts in which it will be used", bridging "the gap between an initial vague recognition that there is some problem ... to building a system to address the problem" (pp. 3). Another definition for RE proposed in the year 2000 by Easterbrook, in collaboration with Nuseibeh, stated its suitability for specifying what the authors called "real-world goals" i.e. reflecting the tendency for change in the real world.

More recently, Pohl (2010) agrees, adding "*each RE process starts with an aim to change the current reality*" (pp. 42). The author stated all software systems are used within a context, adding while system goals may be clearly defined, quite often variables within the context are not so clear. The latter may explain the rationale for a look to RE methodologies for ML systems. Although not strictly software-intensive applications but many interconnecting systems and technologies; the very nature of the system make it a likely domain for the application of RE.

As Easterbrook & Nuseibeh (2000) stated, RE "*is a multi-disciplinary, human-centered process*" likely to be used in the development of a system most commonly earlier on in the life of a project. Therefore, while it may not be useful for all systems, RE can potentially be of some benefits to a system when operational requirements are required, especially if the system involves a number of processes and stakeholders. The authors disagree with the premise requirement engineering, as the name may suggest, has to do primarily with the search for "*cost effective solution for practical problems*" in "*engineering*" specifications (pp. 36).

Berenbach et al, (2009) would agree with this premise, describing another useful characteristic of RE which concerns its suitability for analysing complex interconnecting systems, especially if rapidly changing factors are part of the features of the system (Berenbach et al, 2009). Each time there are changes in the specification for a technology, expertise in their effective use also becomes obsolete and established processes are no longer fit for purpose. RE can be useful in outlining the system's dynamics such as its characteristics, evaluating its current state and fitness for purpose as well as its effectiveness in terms of intended functionalities. RE can also help in suggesting how it might perform given the introduction of a set of parameters. In this case, the end goal becomes improvements to the system.

A simplified summation of various definitions by Sutcliffe (2013) also describe RE as the process of identifying needs and understanding what those might mean for specific users of a particular system. Sutcliffe (2013) mentioned RE has been compared by some with Human Computer Interaction (HCI). The author however believe RE defers because in HCI, user requirements are seen as part of a process including design, prototyping and evaluation; whereas the more linear process including specification, design, implementation and validation (evaluation in HCI) is more characteristic of an RE process.

It is accepted in several literatures MDT is often used in constantly changing contexts which is not unaffected by changes in its affordability and advances in its features (Lai et al 2007; McLoughlin & Lee, 2008; Rajasingham, 2010; Petterson & Vogel, 2012). Its placement in education which has given rise to the domain ML is also fuzzy conceptually. Thus, an approach to these and many other issues plaguing ML which includes the use of RE technique may offer a different perspective from current literature and efforts in the domain. This may also encourage opportunities for further rigorous research and inquiry-based approaches.

As MDTs become commonplace around the campus and in students' "pockets", this thesis is concerned with how they may become more formally integrated and effectively utilised to transform learning. The review of this thesis focuses therefore on the relationship between MDT and education, asking if a co-evolutional relationship between both could help advance the agenda for the domain. On the other hand, it may in fact be the case MDTs can only enhance informal, personalised learning and collaborations, where they are believed to already yield some benefits (Clough et al, 2007; Rajasingham, 2010; Andersen, 2011; Abdullah et al, 2013). It is considered discovering its precise placement in education through rigorous research, whether niche or not will be of some advantage.

An additional desirable consequence of this exercise is the establishment of requirements for ML through RE techniques and alignment with institutional goals. Increased visibility in learning could also lead to an understanding of the “app” or bite size application culture. Given the increasing tendency of MDT manufacturers to promote devices through apps and the number of businesses creating small learning apps to encourage the use of their services or drive traffic to their websites, a better understanding of the phenomenon is needed and how they may affect employability of new graduates (Traxler, 2012). An unintended by-product of the process may also be a better understanding of requirements for BYOD systems.

1.6. Change management: Herzberg's dual-factor theory

Although not the subject of this thesis, Herzberg's two-factor theory has a tenuous relevance. The theory suggests satisfaction and dissatisfaction are not on opposing ends of a spectrum. Therefore, increasing satisfaction does not necessarily decrease dissatisfaction or vice versa, and feelings or factors leading to these states may fluctuate (DeShields et al, 2005). This would imply as much as promoting satisfaction (and avoiding dissatisfaction) among students may be a perpetually desired goal for learning establishments, achieving this aim is not a matter of a simple equation. Nonetheless, establishing variables for satisfaction of goals for ML and the integration of MDTs in HE learning as well as those contributing to dissatisfaction (or denial) of those goals are of particular interest to the review of this thesis.

To some extent, the traditional relationship between students and learning establishments can be complex but perhaps obvious. Student to educator, novice to expert, apprentice to mentor etc., the list goes on. However, the sit of power and the dynamics has always been well understood; students sometimes powerless to effect desired changes or obtain satisfaction from their institutions, or avoiding dissatisfaction. This may explain in part the perceived tardiness in HEIs’ response to unending calls for learning transformation and student-centred learning right across the board.

Establishing learning processes which takes advantage of "*the mobile nature of" MDTs*" to allow "*students to have easy access [to learning] at home and at school*", wherever they are, and to "*work at their own pace*" is considered student-centred learning and perhaps one that might lead to satisfaction for students. However, the best of learning establishments' current practices have been described as "*the use of technology to automate current teaching and learning practice*", retaining the status quo for the most part. This is far less than is considered required in today's technological age as far as Mulders (2013) is concerned:

Misguided or not, politicians may be "*making a terrible change for the society in terms of social equality and justice*" as an academic commented to the researcher on the review of this thesis, but it could be assumed addressing the power imbalance between students and learning establishments is considered a duty. This invariably creates another power hierarchy between politicians and learning establishments; the latter having very few recourse but to toe the line. As noted by an academic: "*Transformation has been forced upon higher education through quite aggressive policy-making. We don't have a choice other than to respond.*"

Notwithstanding the dynamics between the politicians and learning establishments may sometimes leave the latter scrambling just to hold its head above the water, it may however have succeeded in balancing the power between students and learning establishments to some extent. In the tuition-fee paying culture, the relationship now, it is believed, is increasingly a business relationship: that of *customers* to *learning providers*. It is therefore anticipated students may now feel empowered to effect the changes they desire at last, in a heighted and competitive HEI environment (IPPR, 2013).

One problem yet to be addressed is the question of what form learning transformation should take. Technology-enhanced learning (TEL) is one of the more recent phrases brandied about in educational circles but it is not the only one. Should current learning be left as-is or made more flexible, blended, virtual etc., or is a flipped classroom needed? Readily available technologies and rapid ongoing advances in developments of MDTs make them rich for speculation and appropriation. But precisely what benefits could they offer, if any?

For Mulders (2013), it is a very simple matter:

> *"What is required are innovative teachers and Heads who are willing to cast off the shackles imposed by the use of technology to automate current teaching and learning practice and begin to explore these new didactic models which support more fully the independent learner."*

Aoun (2014) agrees, but the discourses in this chapter may have shown it is not quite that simple. Asking questions may be a good start and one that has begun in this chapter. Perhaps the questions should start from a consideration of what it would take for Kay's dream for the "*learner child*", fully participatory and active in its own learning, constantly "*curious*" about its own environment and making meaning from what it finds, a common occurrence in HEIs (Kay, 1972, pp. 6). Can MDT play any part in achieving these noble objectives, as many including Mulders (2013) and Aoun (2014) seem to believe, or is it in fact part of the problem? How can expectations of staff and students be matched, and the mismatch suggested by Kukulska-Hulme (2010) eradicated?

These are just a few and more questions may be asked during the review of this thesis. While this review is not concerned with establishing guidelines for the use of MDT in learning therefore, it is anticipated there may be implications for some applicable and replicable guiding principles. The use of RE techniques to investigate the domain is also of some considerable benefit for the future, re-directing research focus into new methodological approaches for investigating problems in the domain. In addition, RE techniques may provide means of evaluating ML processes and perhaps also of evidencing benefits to learning.

1.7. The thesis in brief

This thesis is an account of review study conducted among stakeholders in UK HEIs and mobile device manufacture industry. Stakeholder groups consulted for the review of this thesis include educators and academics; students, including UK secondary education pre-service tutors and post-graduate researchers; those in learning support and governance and IT support personnel. The review of this thesis explores opinions and perceptions on ML and the use of MDT domain among the listed stakeholders. Influence in the domain of study and relevance to HE learning and teaching are among criteria for stakeholder selection.

Findings of the review of this thesis are summarised in eight chapters. This chapter introduces the review, outlining foundational aims, objectives, background, guiding principles, contexts, relevance as well as providing an overview of the review of this thesis and a brief introduction of the rationale for employing methodologies of RE and AOSE disciplines to study the domain of ML, and the adoption and integration of MDT in educational practices, in a bottom-up approach. This is a departure from most of the approaches to research activities in the domain which are predominantly top-down, comprising of justification for MDT use through exemplars and experimentations.

The literature, systematic and critical analysis reviews conducted to establish the state of the art of ML as a concept are presented in Chapter 2, gathered from online databases such as EBSCOhost, ISI WoK, IEEE Xplore etc. The chapter summarises existing literature and publications on ML and the integration of MDTs in learning processes in the last decade.

Approach and methodologies employed in the review of this thesis are detailed in Chapter 3, including rationale for stakeholder selection for requirement analysis. Philosophical perspective guiding the review and the role of the researcher are also explored. The chapter also details how access to data in HE was made easier by opportunities for informal observations and note taking over a period of several years from insider perspective, with the implications considered.

In Chapter 4, the techniques available in the discipline of RE, introduced in this chapter, are explored in more details, along with a case study to illustrate some techniques. The benefits of using some of the techniques are illustrated with models arising from application within ML system in an HE environment. The application of RE techniques as well as methodologies for AOSE in requirement analysis is one of the conceptual frameworks underpinning the review of this thesis.

Chapter 5 provides a discourse on UK HE ecosystem and students' demographics, *experience*, motivations and expectations for HE learning as well as learning approaches in higher education. This is another of the conceptual framework underpinning the review of this thesis. Existing literature on learning theories are summarised and considered as relevant to adult learning and the dynamics at play in 21st century learning environment. Instructional Design (ID) and content in the contexts of MDT adoption and integration are also discussed, as well as some of the environmental and infrastructural issues faced by both learners and teaching staff. These are explored using relevant data from primary and secondary sources.

Findings from primary sources during the review of this thesis are presented in Chapters 6 and 7. In Chapter 6, the results from the comparative study among stakeholders, qualitative interviews among HE practitioners and longitudinal study of freshers (new entrants into higher education) and pre-service tutors are presented. Chapter 7 presents a series of models for ML based on the findings of the review of this thesis and in Chapter 8, findings relating to co-evolution relationship between MDT and education are discussed, along with conclusions and recommendations for the future. The thesis ends with a final comment summarising some of the key aspects of the review.

Chapter 2

The phrase 'mobile learning' portrays it as a version of learning, the mobile version ... it might be easier to see, not as the mobile bit of learning but the learning bit of mobile.

~ Prof. John Traxler ... in conversation with Janet Clarey

Mobile phones are misnamed. They should be called gateways to human knowledge.

~ Ray Kurzweil, Google

ML and MDTs: Historical contexts

2.1. ML in practice: A review of literature

In 1965, Gordon Moore (co-founder of Intel) suggested computing power doubles within 16 months to 2 years (Moore, 1965). The rate of advances in MDT is estimated at less than 6 months (Kim, Peng et al, 2009). Many devices are capable of performing tasks similar to those for which powerful computers were previously required and much more. Tablet Personal Computers (tPCs) and wearable devices are increasingly common in the marketplace; the latter only fully operational when paired with smartphones, tablets or PCs. MDTs are also creating convergence of multiple media equipment such as audio, video, camera, GPS etc.

The rate of penetration and pervasion in the society is also remarkable. There is an ever growing demand driven by their 'at easy reach' ability to become solutions for communications and social interactions. One of the behavioural changes is now termed "*media meshing*" i.e. performing tasks simultaneously on two or more media devices e.g. TV and mobile phone. For example, 80% of the 2.6 million tweets using associated hashtags, posted during the airing of the 2013 Wimbledon Men's tennis final were from MDTs and breaking news are often transmitted across the world using MDTs and providing up-to-the minute account of events as they unfold (Ofcom, 2013).

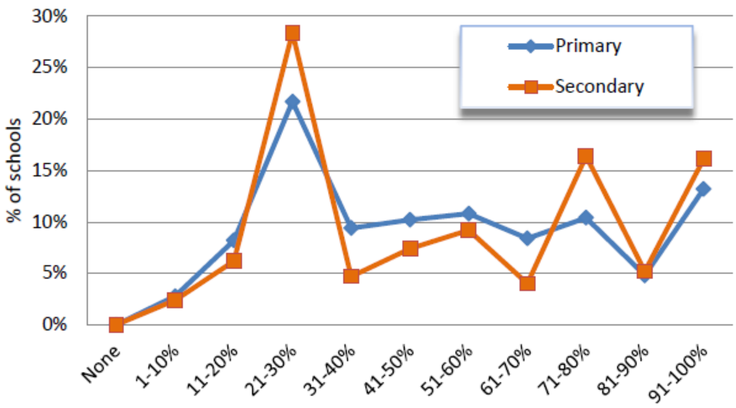


Figure 2.1: tPC penetration in UK Primary and Secondary schools (BESA, 2013, pp. 14)

From reminder alarm functionality to media players and recorders, location-aware services, safety control systems, remote connections or control of powerful applications, as well as collaborations across geographical divides, the impact of MDTs are unavoidable. Access to robust and often free wireless connectivity is also growing, especially in developed countries. As a result, new business streams are generated along with new career opportunities. An Oracle study conducted in July 2011 suggest consumers are becoming increasingly “data-hungry”, downloading over 300,000 applications to their mobile devices, 10.9 billion times in the previous 3 years (Oracle, 2011, pp. 3).

Secondary data presented in Section 1.3.2 suggest MDT ownership is growing among students but classroom uses are primarily for access to lecture notes / VLE materials, note taking or session recording etc.; their assumed potential to enhance / transform the learning largely unachieved (Clough et al, 2007; Looi et al, 2010). Educators either tolerate their informal use or ban them for being too distracting or disruptive to sessions; not only because of the tendency for learners to drift away from tasks in hand into other (perhaps less relevant) tasks, but also because there are potentials for cognitive overload which could also be particularly frustrating for learners (Keegan, Lee & Chan, 2007; Kim 2009; Belshaw, 2010).

Consequently, ML is considered to be in a state of flux in learning establishments; the story different for different levels of UK’s educational sectors: primary, secondary etc. For example, a BESA report projected primary and secondary schools are increasingly replacing PCs and Macs with tPCs (tablet PCs), suggesting teaching and learning on tPCs will grow in the years to come (see Figure 2.1; BESA, 2013). Some of the uses include integration in curriculum delivery of ICT, Literacy and Numeracy. In contrast, progress of ML in HE is believed to be stalled (see Figure 1.1; Walker & Voce, 2014).

In this chapter, existing literature on ML and the use of MDT in learning is summarised to provide a background for the review of this thesis. Findings from a systematic and critical review analysis conducted during the study are also presented. This will lay a foundation for the rationale for RE techniques suggested in Chapter 1, considered in more details in Chapter 4.

2.2. Changing face of MDTs

Mobile Device Technologies (MDTs) have undergone various changes since its inception in the early 1970s; so much so that some of the current models are sometimes unrecognisable from the first ones to appear in the marketplace. A brief history of MDT's progression has been presented in Chapter 1 and Appendix 16 and 17; along with difficulties experienced with integration attempts into learning early on. From the launch of 2nd generation mobile devices and networks along with touch screens, PDAs and smartphones; MDT appear to have taken a leap in its design and penetration, becoming one of the must-have technologies in this age. Tablet PCs (tPCs) and wearable devices are latest additions, with standard features such as touch screens, large storage space and / or facilities for removable storage, powerful computing power, GPS, Short Message Service (SMS) text / Multimedia Message Service (MMS) messaging, video communication, media features etc.

Projects involving the use of MDT in education began in late 1990s but publications did not appear until 2002. Most were proceedings of the *IEEE International Workshop on Wireless and Mobile Technologies in Education* (WMTE), arguably the first international conference on the use of mobile devices in learning. The emergent of smart phones and PDAs in the 1900s inspired several of these early articles and projects, as did Apple's release of the first generation of iPod devices in November 2001. Other notable turning point events include the invention of wireless technologies and, directly or indirectly, the drive by successive incumbent governments in the UK to implement robust internet and WiFi connectivity across the country.

From the late 1990s to early 2000s, MDT's foray into education can be seen as terms like e-learning and blended learning were increasingly less used or mentioned alongside new terms like mobile learning, personalised learning, informal learning etc., in educational cycles. McConatha (2008) suggested Mike Sharples may be one of the early advocates of ML as a concept, with references to the practice in *Computers and Education* in 2000. However, Abernathy's article in 2001 (cited in McConatha, 2008) titled "*Get ready for m-learning*" may arguably be one of the first detailed articles on the subject.

Referring primarily to the practice now known as workplace learning, Abernathy's article is rather predictive in the abstract sense, suggesting mobile devices like PDAs and laptops may provide flexibilities in learning. It also included a few examples of implementations; many of the early trials typically devoted to provision of activities to augment learning. SMS messaging ushered in instant feedback and in-session texting / response era. Using online platforms / applications, the projects by and large facilitated provision of instant feedback to students' question during learning sessions. Some are also used to prompt students to further informal study (Markett et al, 2004; Arreymbi & Draganova, 2008; Banister, Olasoji & Draganova; 2010; Cornelius et al, Lim et al, 2011).

App development was another turning point in the late 2000s. Small purpose-built learning applications called "apps" were developed for Apple devices. The applications are usually developed and deployed in Apple's online apps store, iTunes, by freelance third party developers. Some are free for installation or sold for relatively small amounts. Educators, content developers and device manufacture pundits believe this may have added to the popularity or preference for Apple devices (CiCS University of Sheffield, 2011; BESA, 2013). Google's Android and Microsoft's Windows Store have now joined the app platform bandwagon, providing online markets where developers could deploy apps for devices on Android Operating System (OS) or Windows-based OS for MDTs or tPCs.

MDT standards are now in the fourth generation (4G), with ultra-fast wireless infrastructures and standards. Potentially, it is believed 4G could offer faster mobile web access, high definition / 3D TV and gaming on mobile devices (He & Zhao, 2008). This may perhaps give rise to, or emphasise the use of several emerging educational phrases such as tv-learning / t-learning and virtual learning or augmented learning / a-learning. While 4G connectivity pricing is currently considered prohibitive, this has not discouraged estimation of its potential impacts on the mobile and cellular industry as well as education.

Another area of recent interest is the use of Quick Response (QR) and Mobile Tags (MT) for coding specific content which can be downloaded to some devices using apps specifically created to interpret the codes. Saravani & Clayton (2010) derived a conceptual framework for QR and MT coded content which the authors used in a trial. Learners can use Smartphones capable of reading the coded information with the aid of camera and specialist software. The authors believe this will give learners quicker access to context aware mobile content providing further information on certain subjects, in public places that is timely and relevant (e.g. museums or historical establishments).

2.2.1. Limitations of MDT, then and now

There were no shortage of references to limitations and difficulties experienced during MDT integration in learning, in publications then and since. Abernathy's 2001 article referenced by McConatha (2008) saw costs, poor device standard and designs prohibitive in the early days; although there were expectations then the situation would improve. Portability may be a desirable feature of mobile devices (Moallem, 2005), but the downside of this is the typically small data screens and input keys very early on.

Several researchers and educators commented on the limitations imposed by small storage / memory and screen sizes for learning (Clough et al, Litchfield et al, 2007; Wang et al, 2009). In a trial, Clough et al (2007) found small screen sizes contributed to usability issues and Wang et al (2009) theorised using small keypads / onscreen keyboards to input texts may add to distractions during lessons. McConatha (2008)'s faith, along with that of many others looking to a brighter future for MDTs seem to have been rewarded as issues relating to small screens and text input is fast becoming a thing of the past for the most part, resolved through advents of tPCs and large screen devices or the realisation screen size / text input limitations may not be as important or applicable to everyone (Thurrott, 2012; BESA, 2013).

Variation in screen sizes is still a problem however, along with capabilities and functionalities to design content for, as identified by Kim (2009). Content designers must be aware access to materials may be through small as well as larger screen devices. Consequently, there is still a need for well-designed, condensed or bite-sized learning content. Layout and placement of text and image or animation should also be carefully considered. Texts may have to be prioritised over graphics or multimedia illustrations or animations. Font sizes and width of text on the screen will also be important and availability of suitable learning content may be an issue still, given the variety of device types.

Device battery life may still be a problem as identified by Serhani et al (2009). This may be magnified in a BYOD scenario as battery life duration varies from one device to another. The more feature-rich a device is, the more likely it is to run out of power quickly, requiring recharge. Availability of free WiFi and "always-on" connectivity in public places in developed areas has been presenting some possibilities. However, some learning apps may require considerable battery capacity, depending on integrated features. Therefore, considerations for battery life and connectivity will likely continue to be an issue for some time yet.

Serhani et al (2009) also found platforms and operating systems (OS) on the devices present problems. The authors categorised available platforms into two types: browser-based and Java. There are also several operating systems to choose from which include Windows CE / mobile, Palm, Symbian, iOS for iPhone, Android, Windows Surface RT / 8 and Blackberry etc. The type of application / content that can be made available for devices depend on which platform or OS it uses. A developer respondent consulted in a preliminary study suggested older devices cannot be discounted as many still own and use them. Serhani et al (2009) agree, adding security of private data and access list over wireless networks could also be a problem.

The type of text input keypads on the devices and modes of accessing learning content may also be a limitation still. Saravani & Clayton (2009) suggested learners find keypad dependent access to content clumsy, time-consuming and frustrating. Wang et al (2009) agreed, commenting on the problems with input keypads on MDTs used on a project. Many devices still have keypad dependent applications and content. Even those with touch screens may have on-screen input keypads or predictive texts which have been found flawed with various usability issues (Poirier & Sad, 2008; Wang et al, 2009). Wang et al (2009) theorised learners may be distracted while going through the often laborious process of inputting / extracting texts, preventing "deep learning" or discouraging continued use. Students surveyed in a preliminary study agree but add they are used to it, suggesting frequent use may reduce the impact of this particular issue.

2.3. The state of the art of Mobile Learning (ML)

The depth of confusion around the practice of ML is a standard reference, common in literature. The conceptual understanding of ML can be as diverse as the numerous definitions proposed for the concept by researchers and educators (Frohberg et al, Peng et al, 2009; Belshaw, 2010). In total, a review conducted for this study found 118 definitions / descriptions for ML in a review of 859 publications, some re-cited from other sources (re-cited definitions counted only once). This may explain why it is difficult to evaluate or categorise ML practices or why it is difficult to identify benefit(s) to the learning process (Traxler, 2007; Frohberg et al, Peng et al, 2009).

However, defining ML is considered of some considerable importance; and in general, studies into the use of MDTs in learning tend to start with definition, a position on definition and / or observations on failure to reach a consensus. There are also issues relating to placement in education and continuing understanding of the concept as a whole (Winters, 2006; Frohberg et al, 2009). A case in point is Frohberg et al (2009)'s review which discovered 102 ML practices between 1996 and 2007, categorised using the task model (Taylor et al, 2006) in terms of tools, control, communication, subject and objective (see Table 2.1 and Appendix 15).

Table 2.1: Rating and categorisation for tools

Rating	Indication
1	**Content delivery** to mobile devices; learner are passive recipients
2	**Interaction** e.g. quiz or content encouraging learner to seek further answers within the learning context
3	**Guided reflection**; learner is given tasks that lead to reflection on solutions found in the learning context
4	**Reflective data collection**; learner independently explores the learning environment, using devices to identify, collect, reflect and infer some meaning from new discovery
5	**Content construction**; learner are content producers, actively creating learning content using the tools

Constructed and reproduced from Frohberg et al, 2009, pp. 315-316

Each category was rated from low to high on a scale of 1 to 5 and classified according to the underlying *pedagogic ambition* and the *level of complexity* of the learning environment. For example, tools used in each project will be assigned a value between 1 and 5 depending on the pedagogic objectives to be achieved and the complexity of usage. Rationale for the ratings are outlined Table 2.1 for illustrative purposes.

The process reveals variations in characteristics (see Appendix 15) that some, including the authors, believe may be a reflection of the lack of consensus described earlier (Duncan-Howell & Lee, Traxler, 2007; Dyson et al, Frohberg et al, Peng et al, Wang, 2009). Practices will usually be based on whatever conceptual understanding is held on ML and may also be based on exemplar practices around at the time of inception.

Table 2.2: Integration level of mobile device tools in ML practices

	Indication	Likely contextual considerations
1	**Content delivery** to mobile devices; learner are passive recipients	Learner may be mobile (not in a fixed location), and download may fit anywhere, at any time scenario ... But if there was any cognitive gain, was mobile device used to achieve the gain? Could any other technology work just as well?
2	**Interaction** e.g. quiz or content encouraging learner to seek further answers within the learning context	Learner may be mobile, and interaction may be on a mobile device, leading to cognitive gain ... But without further interaction with contextual information in the immediate environment, other technologies could work just as well as a medium for accessing the interactive content.
3	**Guided reflection**; learner is given tasks that lead to reflection on solutions found in the learning context	Both scenarios may provide opportunities for integrated use of mobile devices to achieve cognitive gain. This may be as simple as note taking, image capturing or audio recording / annotating on discovery field trips or reflections on contextual content using mobile devices ... Here, affordances for note taking, image capturing & recording on the mobile device aided the reflective process.
4	**Reflective data collection**; learner independently explores the learning environment, using devices to identify, collect, reflect and infer some meaning from new discovery	
5	**Content construction**; learner are content producers, actively creating learning content using the tools	Learner has opportunities to make full use of several educational affordances on the mobile device to become producers and co-creators of learning content. The integration of the mobile device in the learning process is considerable and it may be impossible to achieve the same gains without mobile devices. Frohberg et al (2009) admit achieving this may be difficult.

Constructed and reproduced from Frohberg et al, 2009, pp. 315-316

The concept is known by terms which include "*mobile e-learning*", "*ML*" or "*m-learning*" (Traxler, Duncan-Howell & Lee, 2007; Peng et al, 2009). Taken literally, these terms could imply *mobility* in the technologies, the learning process and / or learner. There are several schools of thoughts on whether the emphasis should be on an ‘either’ / ‘or’ basis, or if all conceptual understanding of mobility should be present for a practice to be classified as ML (Winters, 2006; Peng et al, 2009).

Consideration of tools integration in the first scenario in Table 2.2 may illustrate the basis for the difficulty. The table speculates on the level and characteristics of this integration. In the first scenario, it may be assumed it is a description of a practice which ‘pushed’ learning content to learners. There may be a way of confirming learner access but whether learning occurred subsequent to that access, or for that matter, if the ‘pushed’ content was successfully downloaded to the device may be difficult to ascertain.

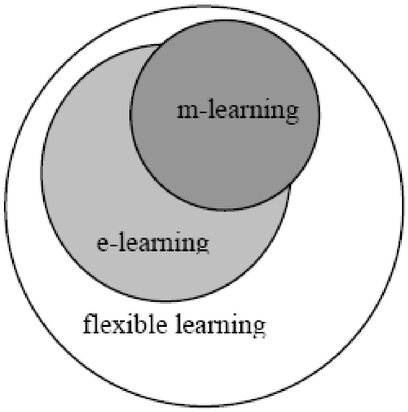


Figure 2.2: Model for m-learning (Yi et al, 2009, pp. 727)

Learners involved in practices categorised in scenario 1 (Table 2.2) may experience learning gain but it may be difficult to get away from the fact MDTs are simply delivery tools of choice, and perhaps other technologies could be substituted, working just as well. The second scenario raised the bar since some form of interaction with the learning environment is expected. However, the nature of interaction with the learning environment will need to allow for the use of affordance features on the MDTs for their use to be more than just a delivery tool.

To use MDT effectively in this particular scenario, the ‘pushed’ content may be designed in a way that motivates the learner to embark on a journey of discovery learning involving subsequent use of the tool. This may include identification, noting, recording, reflection etc. Most importantly, these activities are accomplished using the affordance features in the device. The potential for this to occur and for these activities to result in cognitive gain may be seen more explicitly in each succeeding scenario (3-5) in Table 2.2.

2.3.1. In search for a definition for ML

Given the issues discussed in the previous section, the question of what ML is may have to be considered with some degree of rhetoric. As Belshaw (2010) stated, "*despite over ten years of research into mobile and wireless technologies and numerous projects, the concept of what comes under its auspices remains problematic*" (pp. 7). The need for a consensus definition for ML may stem from the necessity to differentiate it from other forms of learning such as e-learning. Belshaw (2010) contends it "*is not simply an impoverished version of 'e-learning'*" (pp. 7). Be that as it may, researchers often link both; either assuming they are one and the same or ML is an e-learning process using MDT tools.

For example, Figure 2.2 show a placement of "m-learning" in relation to flexible learning as a component part of e-learning (Yi et al, 2009, pp. 727). This may be considered representative of a school of thought on the matter including Rajasingham (2010) who proposes "*m-learning as a subset of e-learning to effect a new paradigm of higher education*" (pp. 2). The rationale may be influenced by the author's believe e-learning is "*accepted for expressing the effort to transform educational processes*" (pp. 1). Sarrab et al (2012) suggest ML is "*the next generation of e-learning*" (pp. 33).

Given the situation, a distinction may be necessary if the concept is to obtain recognition in its own right; as a blogger on JISC Digital Media (n.d.) explains:

> *"Mobile learning is considered to be the ability to use mobile devices to support teaching and learning. It is the 'mobile' aspect of ML that makes it stand apart from other types of learning, specifically designing learning experiences that exploit the opportunities that 'mobility' can offer us."*
>
> *JISC Digital Media (n.d.)*

Therefore, finding a worthy definition for ML have been suggested a crucial step in identifying benefits and perhaps resolving some of the issues associated with the practice (Traxler, 2007; Attewell et al, Peng et al, 2009). One school see *mobility* as a key characteristic that should be more explicitly clarified in the understanding of the concept, and consequently, in practices that are based on this understanding (Peng et al, 2009). While it is generally agreed *mobility* is important, others offer definitions which may have been driven by the necessity to highlight other characteristics. For example, the MoLeNET project's definition for ML suggest it is:

> *"… the exploitation of ubiquitous handheld technologies, together with wireless and mobile phone networks, to facilitate, support, enhance and extend the reach of teaching and learning."*
>
> *MoLeNET (n.d.)*

Mobility may be implied here but the emphasis seem to be on the *ubiquitous nature* of the "handheld" technologies involved i.e. being readily available for the learning to take place. Consequently, this definition could be applicable to all the scenarios in Tables 2.1 and 2.2, regardless of the cognitive achievement or the nature of the role of "*ubiquitous handheld technologies*" in achieving the objective, as long as they've been used to "*facilitate, support, enhance and extend the reach*" of the process.

While the explicit, or no mention as the case may be, of *mobility* or other characteristics of the process in an ML definition may not be indicative, Peng et al (2009) would argue a definition that does not go far enough to reflect a distinction between ML and other forms of learning, or that of the MDTs employed and other technologies may not be effective. The notion may explain the rationale behind the definition offered by Vavoula (2005), writing for the MOBIlearn project which explicitly include consideration of the *learning* and *learner mobility*. Vavoula (2005) defines ML as:

> *"Any sort of learning that happens when the learner is not fixed at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies."*
>
> *Vavoula, 2005, pp. 11*

The definition would suggest there are two different types of learning: those carried out in transit (when mobile) and those employing mobile technologies. Since the first part of the definition did not specifically suggest mobile device use, it can only be assumed and this presents a different aspect to the concept of ML; one that is not often considered in many literatures. Taken literally, the definition seem to suggest any learning that is not carried out "*at a fixed, predetermined location*" is ML, which may lead to the assumption MDT is unnecessary in the process.

The definition does stress the importance of mobility and emphasises the *learning* rather than any technology used. However, the opportunity for differentiation was missed, given mobility in learning is not a new concept e.g. reading a textbook or holding group discussions while in transit. Cruz et al (2012) suggests there are different connotations to mobility: "*It may mean learning whilst traveling, driving, sitting or walking; it may mean hands-free learning or eye-free learning*" etc. In that sense, substituting the conjunction '*and*' for the '*or*' may perhaps have worked better for clarity.

Justifying the need for a new definition for ML, Peng et al (2009) explored some previous definitions. Hoppe et al and Chang et al (2003; cited in Peng et al, 2009) defines "mlearning" as: "*e-learning using mobile devices and wireless transmission*" (pp. 172). While Peng et al (2009) agree there may be a relationship; the authors suggest ML definitions should also take "*ubiquity*" into consideration in addition to *mobility*. The authors offer the following conceptual definition:

> *"In order to benefit from convenience, expediency, and immediacy, mobile learners use ubiquitous computing technologies to learn the right thing at the right time at the right place."*
>
> *Peng et al, 2009, pp. 175*

The last phrase in this definition may present one of the key areas of contention. Learning "*the right thing at the right time at the right place*" may imply there are specific types of learning suitable / unsuitable for ML process. This idea is not uncommon, shared by several researchers who suggest there must be due consideration for selecting learning suitable for ML as well as making selections for learning content, pedagogy etc (Vavoula, 2005; Belshaw, Koole et al, 2010). Belshaw, 2010 added considerations for the learner and context must be central in planning an ML session rather than the mobile technologies involved.

The definition also does not seem to go far enough to provide a distinction since other types of learning may present the same attributes without necessarily involving MDTs. The reference to "*ubiquitous computing technologies*" which is assumed to be in place of MDTs presents the second likely area of contention. Ubiquitous Computing Technologies (UCTs) may include but are not limited to MDTs but they may also include others that are arguably not considered MDTs.

UCTs have been described as those which extend computing power beyond the desktop which may be applicable to MDTs to some extent. However, the term is primarily used to describe embedded and distributed systems in everyday objects and articles enabling information sharing. Descriptive phrases used for Ubiquitous Computing (UC) include "invisible technology", "technology that disappear", "embedded / distributed", "everywhere at the same time", "transparent interfaces", "context awareness", "awareness capture"; the emphasis here on the mobility, integration and seamlessness (Vasantha, 2010). Ferdig & Boyer (2007) in a book review defines UC as:

> *"Ubiquitous or pervasive computing, as it is sometimes called, is computing that is available through a variety of digital tools wherever and whenever it is needed to support human endeavour."*
>
> *van 't Hooft & Swan, 2007, ix; cited in Ferdig & Boyer, 2007*

Peng et al's (2009) definition for MDT may add to the confusion, suggesting UCTs such as augmented reality objects, sensor grids and virtual reality systems may be classified as MDTs. In recent years, UC and ML have been used synonymously to imply much of the same. Given UC is a discipline in its own right, this practice may contribute to problems with conceptual clarity.

Other definitions are more or less variations of those previously considered including the following:

Trifonova & Ronchetti (2003):

- *M-learning is often defined as e-learning through mobile computational devices.*

Keegan (2007):

- *Mobile learning (mLearning) is defined as the provision of education and training on mobile devices: Personal Digital Assistants (PDAs), Smartphones and mobile phones.*

Duncan-Howell & Lee, 2007 chose to describe the process:

- *What appears to distinguish m-learning from more traditional forms of learning is the potential audience it has access to. As Brown (2005) states it "has the potential to make learning even more widely available and accessible than we are used to in existing e-learning environments" (p.299). It would appear to have the potential to access learners regardless of age, gender, national identity, or socio-economic status.*

Moses (2008) offered "perspectives" from several sources (pp. 23-24):

- *Sharples (2006) cited in Winters (n.d.) suggest "four broad categories":*
    - ***Technocentric:** ML is viewed as learning using a mobile device such as PDA, mobile phone, iPod, playstation portable, etc.*
    - ***Relationship to e-learning:** ML as an extension of e-learning.*
    - ***Augmenting formal education:** Means of augmenting formal education.*
    - ***Learner-centered:** Any sort of learning that happens when the learner is not at a fixed, predetermined location or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies.*
- *Parsons & Ryu (2006):*
    - *The delivery of learning content to learners utilizing mobile computing devices. M-learning is the point at which mobile computing and e-learning intersect to produce an anytime learning.*
- *Kambourakis et al (2004):*
    - *M-learning is the point at which mobile computing and e-learning intersect to produce an anytime anywhere learning experience.*
- *Moses (2008) concludes:*
    - *M-learning is a form of e-learning that involves any learning with the use of mobile device to produce an anywhere and anytime learning experience to*

cater for the needs of different learners and augmenting their formal learning experience.

Sharples, Taylor & Vavoula (2007; cited in Brown, 2010)

- *The processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies.*
  Brown (2010) adds: "This definition holds for mobile learning in formal and informal settings and it does not limit the meaning of mobility to physical mobility. Instead, the given definition of mobile learning reflects that learning takes place across space, time, topics, and technologies."

eLearning Guild (2009; cited in Rajasingham, 2010):

- *An activity that allows individuals to be more productive when consuming, interacting, or creating information, mediated through a compact digital portable device that the individual carries on a regular basis and has reliable connectivity and fits in a pocket or purse.*

Lai et al (2007), McLoughlin & Lee (2008) and others offer descriptions. For instance, Wang et al (2009) theorised that at some point during the last decade, the focus shifted from *technological* mobility to *learner* mobility, seemingly in agreement with Vavoula (2005). This notion may be seen in the progressive nature of the definitions outlined previously, which may also reflect advances in MDT development. In an effort to seek a differentiation for ML from other types of learning, these issues are considered further in Section 2.4.3.

2.3.2. Early trials and implementations

The MOBIlearn consortium project is one of the first large-scale implementation spanning several countries and sectors. The project ran for 30 months from July 2002 and partners include universities, companies and device manufacturers among others from countries including Europe, Israel, Switzerland, USA and Australia.

In the UK, the Learning and Skills Council (LSC) invested a considerable amount of capital (12 million) to fund ML Network (MoLeNET) during 2007-2009. The MoLeNET project is estimated to be another example of large implementations; involving 115 Further Education (FE) colleges and 29 schools in the UK (Attewell et al, 2009).

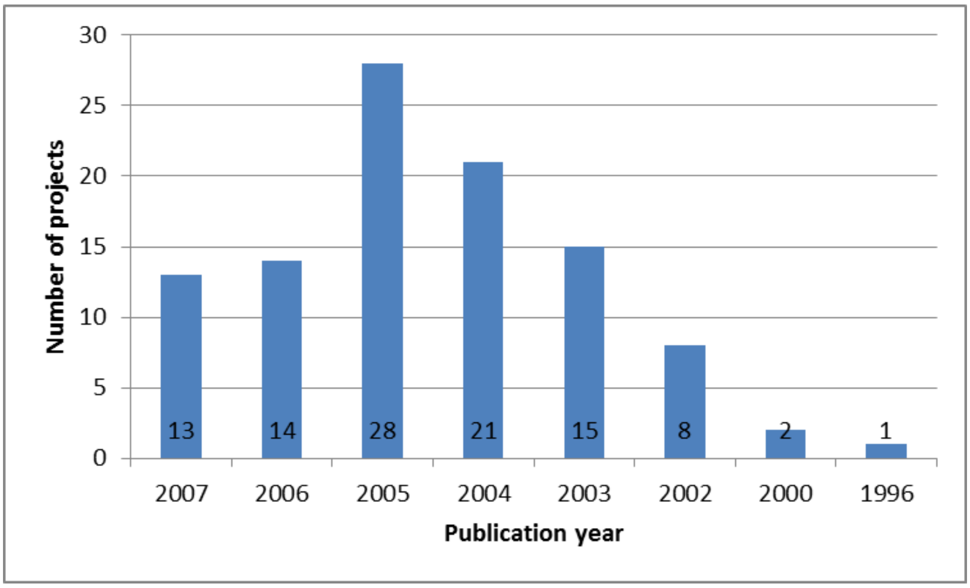


Figure 2.3: Rated ML projects (Frohberg et al, 2009)

Using the task model proposed by Taylor et al (2006, pp. 307-308, 324-326), Frohberg et al (2009) conducted a review which found and categorised 102 instantiations between 1996 and 2007 in conference proceedings and journals (see Figure 2.3). An early implementation of ML from 1996 was included; concentrating on trials classified as occurring in a classroom and therefore in a formal context. Instantiations peaked in 2005 and this may coincide with funding strategies or policies around at the time. Many of these projects ended as a one-off and unsustainable. Keegan (2007) attributed this in part to limited funding and resources.

2.3.3. Citation analysis review

As part of the literature review for this study, a citation analysis review was conducted to investigate the state of the art of ML and the use of MDT in learning more thoroughly.

Review methodology

The study was conducted in four phases involving identification of publication / citation tools databases, publication sourcing, citation data download and analysis of citation data. Online database sources used were narrowed down to

ISI WoK (Web of Knowledge)[2] which offered the benefit of having a citation report tool as one of its features. The search was conducted in January 2013 for articles matching selected keywords (or variations of the keywords) published between 2000 and 2012. Report data was downloaded into MS Excel for further analysis.

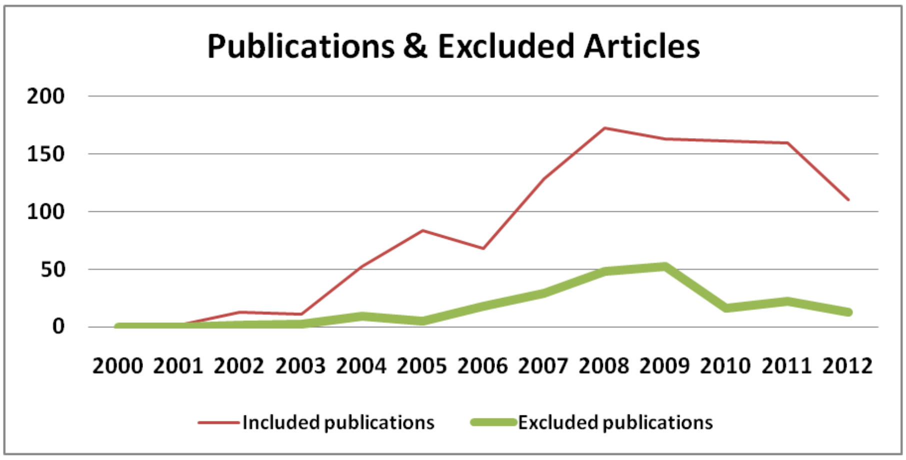


Figure 2.4: Publications excluded / included from analysis

Citation analysis findings

Initial search results returned 1,341 documents published between 2000 and 2012 in the field of ML. A total of 215 were excluded for irrelevance, leaving 1,127 articles downloaded and included in further data analysis using Excel. (See Figure 2.4 for details of excluded articles by year or publication.) It was not possible to exclude discarded articles from returned results on ISI WoK before performing citation analysis as exclusion can only be done page by page. Consequently, overall citation data obtained from ISI WoK included discarded articles and was based on the initial return of 1,341 documents.

Results overview

There were 499 journals / proceedings and 735 conferences in the final citation data. Table 2.3 shows overall citation data for documents included in further analysis using Excel. Analysis summary as shown on ISI WoK indicated *self-citations* account for 43.44% of the *total citation count* (2,873). *Average of citations per article* was 2.14; *citing articles' count* was 1,595 and count of *citing*

[2] http://wok.mimas.ac.uk/

articles without self-citations was 1,190.

Table 2.3: Overview of citation data

Total publications	1,127
Sum of the times cited (all publications)	2,345
Average of citations per article:	2.08
Top h-index	24

The *h-index* (also known as Hirsch index or Hirsch number) shown in Table 2.3 is believed to be a measure of an author's impact within a field of study; calculated from the number of papers (Np) the author has written and the number of citations (Nc) for each paper (Ireland, MacDonald & Stirling, 2013; cited in Alakanga & Warburton, n.d.). In Table 2.3, 24 authors / publications were found to have been cited at least 24 times. This accounted for 40.97% of the total citations count. It is important to note that 3 (7.87%) of the articles included in the *h-index* calculation were eventually discarded from this study.

The 24 articles included in the *h-index* were published in 7 journals:

1. *BMC Medical Education (1 article)*
2. *British Journal of Educational Technology (1 article)*
3. *Computers & Education (9 articles)*
4. *Educational Technology & Society (3 articles)*
5. *Electronic Library (1 article)*
6. *Journal of Computer Assisted Learning (8 articles)*
7. *Personal and Ubiquitous Computing (1 article)*

The three discarded articles were published in BMC Medical Education (1), Computers & Education (1), Educational Technology & Society (1).

Limitations of the citation analysis

One of the limitations of this study concern reliance on one online database source for the analysis data, because the citation analysis tool used was provided as a feature on the portal. Therefore, exclusion of articles, books, journals and conference proceedings not indexed by ISI WoK may have resulted in some inaccuracies.

A major criticism levied against citation analysis about the likely motives behind citations may also be a limitation in this study. An article may have been cited for content other than those relevant to the main focus of the article or the contexts of the subject matter. In this respect, it is uncertain if the citation could be considered an influence in the domain relevant to the review of this thesis. It is also impossible to know for certain if an article was cited because it is the best source on the item or for other reasons (MacRoberts & MacRoberts, 2010).

Fraudulent practices have also been alleged within some citation processes. Self-citations as was found in this study and citations by colleagues, peers and for favours or gratuities are quite common and these occurrences may have skewed the citation counts. ISI WoK provided some information about self-citations but there is no way of verifying the process behind citations. Articles included in total citation counts may also be variations of the same article with more or less the same focus, perhaps submitted to separate journals. This study found several examples of the latter, later excluded from further review as duplicates.

Citation analysis discussions and conclusions

The period covered by the citation analysis include publications on ML from 2000 to 2012. A total of 1,127 articles found on ISI WoK provided the data for the citation report. The report showed there were little or no publications on ML until 2001 (see Figure 2.5). Publications in the domain increased steadily, peaking in 2007 and have declined each year since. In contrast, citations continue to increase steadily every year. This may suggest researchers believe all the gaps have been explored but there are still some interests in the domain.

Since opinion papers as well as those presenting empirical results were included, the results may only be indicative of trends and influences and best viewed in this light. The study included an examination of the top 5 articles cited overall which accounted for 32.03% (361) of all citations. Three of the articles describe systems that can facilitate deep learning using mobile devices or in a ubiquitous environment involving mobile devices. One of the articles involves the use of podcasts while the last suggested mobile devices can be used for language learning. Two of the articles presented results on trials conducted in a higher educational setting and two are with children in school / elementary school.

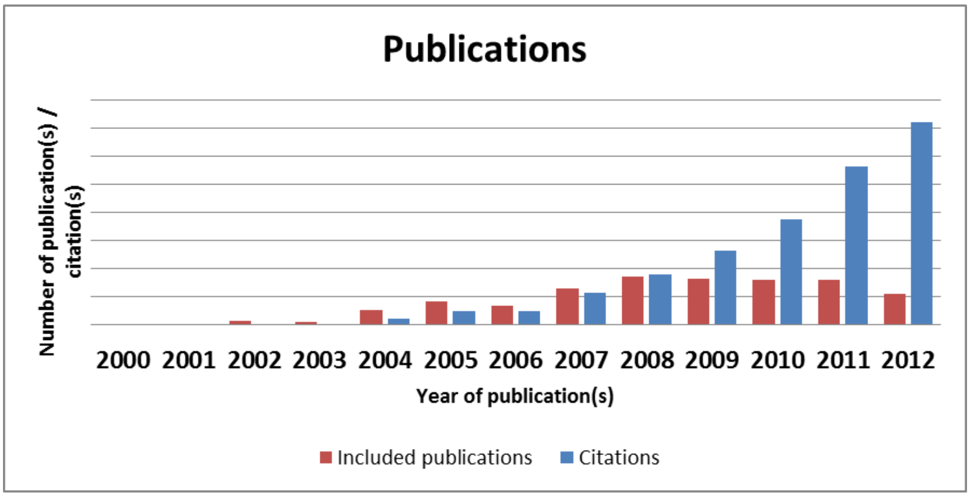


Figure 2.5: Publications and citations by year

Sources for 3 of the top 5 publications are: Computers & Education, Educational Technology & Society, Journal of Computer Assisted Learning. The remaining 2 are conferences proceedings from IEEE International Workshop on Wireless and Mobile Technologies in Education and Fifth IEEE International Conference on Wireless, Mobile and Ubiquitous Technologies in Education. Another feature of the ISI WoK portal is the Journal Citation Reports (JCR) for listings (Appendix 18, Table 1). As well as being at the top of the tables for publications and citations, Computers & Education was also top of the table in terms of journal impact factor with an impact factor of 2.621, a ratio of the number of citations to recent publications.

Both *Computers & Education* and *Educational Technology & Society* contributed 46 publications (4.10%) each while *Journal of Computer Assisted Learning* contributed 26 (2.35%). The article influence® mean score for *Computers & Education* in 2011 was 0.6 compared to 0.295 and 0.525 respectively for *Educational Technology & Society* and *Journal of Computer Assisted Learning*. A score less than 1.00 will indicate there's no dominance and none of the articles in the top journals have above average influence.

It may be noted 32% of the citation data used in calculating impact factor for *Computers & Education* is self-citations. Articles in *Educational Technology &*

Society account for 12% in self-citations and *Journal of Computer Assisted Learning* for 18%. More details on the JCR data for these three journals can be found in Appendix 18, Table 1.

Of the 24 articles in the *h-index*, 3 were unrelated and discarded before analysis leaving 21 (see Appendix 18, Table 3). Keywords used by the authors reveal an eclectic collection, providing little or no clue to the motivation for selection. Some of the authors seem to have a high level of self-citations in relation to the others and several of the articles did not seem obviously related to ML from the keywords though they were found to be. All papers were categorised in *Education*, *Educational Research* or *Science* areas and publication dates ranged from 2002 to 2010.

A quick scan of the abstracts reveal some of the topics include the use of podcasts to augment lectures, SMS messaging in / out of sessions, using sensors for context awareness and wireless mobile devices to augment ubiquitous learning environments and some early implementations of ML (see Appendix 18: Table 2). These are of course no clues to the reasons for their popularity which is one of the criticisms levied against the use of the *h-index* as an indication of impact in a field of study. Another criticism concerns its reliance on the authors total publications count which may not be an accurate indication of impact. Authors with very few publications and a high *h-index* does not necessarily imply quality.

Some of these limitations and others inherent in citation analysis as a process, outlined previously, were also found to be applicable to this review. Assumptions about waning interests and citations count must therefore be taken in the right contexts, along with the reliance of this study on data from articles listed only on the ISI WoK portal. The citation data also failed to include information about countries and cities of the publications or empirical trials outlined in the publications.

2.3.4. Systematic review analysis

Systematic review analysis is another study conducted as part of the literature review for this research. This section outlines findings from the review process.

Review study design

Around the late 1990s, references to mobile devices began to appear in some e-learning publications. By the year 2000, many had started referring to this practice as ML, confirmed in an article by McConatha (2008) who identified Mike Sharples as one of the early proponents. Keh et al (2000) also describe a mobile notebook tool on the web, stating the tool could be used by students to "*edit or read their notebook anywhere any time*" (pp. 251). Educational technology development timeline (see Appendix 17) would also support this assumption, locating the start of ubiquity in portable / advanced mobile technologies in the 2000s.

Similarly, a systematic review commissioned by the Learning Light[3] for workplace learning found some evidence to support the use of MDTs in learning processes. A report on the study by Nunes & McPherson (2007) found iPods, PDAs and mobile phones were being used to access materials, audio, voice casts and multimedia learning contents. While the research failed to include date mapping, there were indications practices including the use of MDTs were relatively recent and very much in the emerging stages.

Therefore, a decision was made to include full-text peer-reviewed publications spanning 2000 to 2012 in the systematic review. Questions and some of the design ideas used in this study were inspired by the Learning Light study (Nunes & McPherson, 2007) and a study of research trends in technology-based learning (Hsu et al, 2012). Motivated to fill perceived gaps in research for evidence of exemplars of good practice and usage analysis, the latter was conducted among SMEs (Small-Medium Enterprises). Notwithstanding, the objectives outlined in both were found to be not so far removed from those which inspired this study. An unintentional by-product of using similar review methods is the possibility of comparing findings; especially those obtained on MDT usage.

[3] http://www.learninglight.com/

While Nunes & McPherson's (2007) study reported on the use of mobile devices, the study did not include an investigation of the extent of use and penetration in learning. Hsu et al's (2012) study analysed publications of "*mobile and ubiquitous learning*" as a category among 12 others. They found publications on the topic grew from 1.40% to 2.59% between 2000 and 2004. Again, the extent of use and penetration in learning was not included in the study. This study aimed to address this in line with the following four-fold objectives:

1. *To summarise existing literature on ML and the use of mobile devices in educational processes containing relevant evidential research in a systematic process conducted without bias.*
2. *To locate progress in MDT integration in learning processes and compare with educational technology timeline.*
3. *To provide an overview of current practices, which may inform future policies and practices in ML, and the use of MDT in educational processes.*
4. *To identify gaps in practices and research and to suggest areas requiring further study.*

The study is also expected to provide some clarity on the current understanding of ML as a concept and an overview of the progression in the general understanding during the review period.

Questions for the review

The questions asked in the Learning Light study (Nunes & McPherson, 2007) have been modified to include others as relevant. The main question for the review of this thesis can be summarised as follows (see Section 3.2.1):

To what extent and in what ways has MDTs been integrated in educational processes since its conception?

In providing answers for questions for the systematic review study, it is anticipated answers may also be provided for questions outlined for the review of this thesis in Section 3.2.1. Questions for the systematic review process are as follows.

Practice-based questions:

- What factors influence successful integration of MDTs in educational processes?
- What barriers impede successful integration of MDTs in educational processes?
- What evidence exists through practices on impacts / influences on teaching and learning processes?
- What frameworks or benchmarking methodologies have practices been based?
- What are the influential characteristics of implementations / practices e.g. types of institutions / countries of origin / educational levels etc?

Conceptual and theoretical questions:

- What is the current understanding of the concept of ML?
    - o *What studies have been carried out to support this understanding?*
    - o *What types of research methods are used in these studies?*
    - o *What data collection methods are used in these studies?*
    - o *What are the findings of these studies?*
- Is there a differentiation between e-learning and ML evident in conceptual understanding / practices?
- What are the contributory characteristics informing the conceptual understanding / practices of ML?

Review methodology

The study was conducted in three phases which included compilation of relevant keywords and identification of publication sources (online databases), selection of publications for further analysis. Several online databases were considered. However, it was clear almost all of the full-text publications available on ISI WoK and ACM were also available on EBSCOhost and IEEE Xplore. Consequently, both IEEE Xplore and EBSCOhost were selected as sources for documents to be included in the review.

A CAQDAS (Computer Assisted / Aided Qualitative Data Analysis Software) called ATLAS.ti[4] was chosen for the process of automating the coding process and querying of the texts. While there are other software applications like NUD*IST[5], ATLAS.ti was selected because it is intuitive and easier to use. Its visual features are also found to be more user-friendly and robust than in

[4] http://www.atlasti.com/index.html
[5] http://www.dartmouth.edu/comp/soft-comp/software/downloads/windows/nudist.html

NUD*IST; providing options to create visual relationships between codes and code networks.

Qualitative analysis of texts in this manner requires good coding system to be effective. The codes used for the review of this thesis was initially based on the questions and categorised accordingly as top-level codes. Subsequent levels were sometimes derived from the texts or from current understanding of the concept of ML and / or the use of mobile devices in learning processes. ATLAS.ti provided a robust feature for creating codes; explained in more details in the next section.

Limitation of the review process

The first limitation is the lack of manpower to read the texts. Since the process was essentially a review of literature, the articles required careful "scan reading" to ensure relevant texts are not missed. This was a slow and laborious process; decidedly limiting the number of articles checked manually for possible errors. Also, because it was impossible to read every single text within the articles, some pertinent details may have been missed. The initial skim-reading of the articles to find those fitting the parameters set could also have excluded valid articles if relevant information were not included in titles, abstract and the introduction sections of the articles, or the keywords used to search through within the texts did not match texts used by the authors.

The process also relied heavily on the availability of articles and journals electronically for analysis using ATLAS.ti. It is likely some relevant articles have been excluded because they were not available through selected online databases. Also, the review can only be as good as the quality of the documentation. As Frohberg et al (2009) also found, where only snapshot reports were available; some relevant aspects of the process are likely to have been left out.

Review findings

Overall, a total of 287 ML projects in HEIs were included in the review (see

Table 2.4). The projects are grouped as follows:

Table 2.4: Top ML projects

Code: zz-project / research examples	
Project classifications	**Number of projects**
SMS messaging / feedback	113
Podcasting / language learning	87
Field work / image capture (may involve note taking / audio recording & in-class discussion)	22
Access online learning / revision content	21
Interactive learning application uploaded to device	14
Interactive games	13
Augmented reality	12
Large-scale projects involving several HEIs	4
PBL (problem-based learning)	1
Total	**287**

Majority of the projects are those involving *SMS messaging / feedback* and *Podcasting / language learning*; many of the latter recordings of lectures downloaded by students to mobile devices. Many of the projects failed to define ML or provide an indication of the conceptual understanding on which the projects are based. All reported some benefits to the students involved after the projects have been completed but several indicate further studies may need to be conducted. It is unclear from the review if the practice of ML continued beyond the projects.

Several of the review questions were answered by the findings. However, extensive and more indicative answers may be further gained from qualitative / case studies of ML practices. See Appendix 3 for more details on answers to review questions.

Systematic review analysis conclusion

The review of this thesis conducted a systematic review of articles on the uses of MDTs in education between 2000 and 2012. A total of 859 articles were included in the review and 287 accounts of ML projects. One area of difficulty for proponents of ML is evidencing gains in learning. This is sometimes complicated by the fact that mobile device usage can be dynamic, changing in contexts from one moment to the next perhaps as there are new features in devices or in the technologies.

For those concerned with sustainability of ML, evidencing gains in learning will be crucial. This review found there are still questions about practices that should be described as ML, perhaps rooted in the inability to reach a consensus on definition. Mobile learning definitions codes (*mlearning-state(definition)*, *mlearning-issues(definitions), mlearning-issues(definitions-needfor) etc*.) also reveal there's still a problem defining ML as a concept. Code *mlearning-state(definition)*, proposing new definitions, returned 118 quotations; *mlearning-issues(definitions)* on the importance of finding a consensus or lamenting the lack of one returned 306 quotations, of which 19 quotations (code *mlearning-issues(definitions-needfor)*) suggest there's a need for a consensus (see Appendix 3).

It should probably be of some concern also that *SMS messaging / feedback* and *Podcasting / language learning* are top of the table of ML projects implemented (see Table 2.4). There have been a suggestion some of these activities may not be good examples of the "deep learning" potential expected for learning transformation and perhaps symptomatic of the failings of ML (Liu et al, 2007; cited in Brown, 2010; Valcke, 2011). It may also be worrying for some that in over 10 years of ML, it would seem proponents have not been able to move the agenda forward enough to effect some learning transformation. If MDTs will effect learning transformation, more need to be done to encourage projects reflecting full integration in the process as opposed to peripheral usage (Mulders, 2013).

Speaking of learning transformation, it may be also useful to examine quotations about future trends as related to the review of this thesis (Code: *mlearning-trends(transformation)*; Appendix 3). Some of these include the potential for MDTs to:

- move learning out of the classrooms (Naismith et al, 2004; cited in Dyson et al, 2009, pp. 253).
- effect changes in teacher role (from knowledge transmitter to learning facilitator) and student role (from passive recipient of information to active participant in learning (Duncan-Howell & Lee, 2007, pp. 230).
- improve approaches and align with "technological practices" of students (Dyson et al, 2009, pp. 251).

- better support for learners in “applying, analysing, synthesizing and evaluating their knowledge” (Frohberg et al, 2009, pp. 322).
- provide a bridge between “private and public learning spaces” in a seamless learning where learning is leveraged across contexts (Looi et al, 2010, pp. 156).

All are however considered to be very much still in the conceptual stages and yet to be attained. Issues relating to concerns about potential classroom disruptions are also common; believed to be as result of:

- lack of competency in the enabling technologies surrounding mobile device use i.e. computing software and hardware required for learning applications.
- lack of competency in using the devices effectively (both staff and students).
- the difficulty in engaging students so they are not distracted.
- use of devices without pedagogic underpinning and other relevant considerations.

Future work may include mining more deeply within the texts to gain an in-depth understanding of these issues and others not specifically highlighted in this thesis.

2.3.5. Framework models for ML: Reviewing & evaluating practices

Modelling has been proven as a technique for investigating and analysing complex systems. Framework models and process flowcharts for example can help identify existing and potential problems as well as providing workflow patterns that could streamline the system’s processes. This may explain the call for framework models for ML as an option for promoting the concept for effective learning (Belshaw, 2010). It is believed this is essential for integration and sustenance in education.

However, while existing frameworks for ML have been useful in clarifying some aspects, most seem too focused on particular areas of interest to be effective overall (Peng et al, 2009). Helen Beetham (JISC; cited in Mayes & Freitas, n.d.) believe a focus on certain aspects (e.g. technological affordances) may be ineffective in the learning process. The author suggest any framework must be underpinned by pedagogy and learning outcomes.

Writing in relation to e-learning, Mayes & Freitas (n.d.) maintain there are “*no* *models for e-learning per se*", only models for the use of technology in teaching. The authors describe e-learning models as primarily "*e-enhancements*", generally reflecting the use of technologies to achieve learning outcomes (pp. 4). For an e-learning model to be a model of learning, they believe it needs to demonstrate value-added pedagogical principles. An example given is a situation where learners "*interact with each other and with the representations of the subject matter in a form that could simply not be achieved for those learners without the technology*" (pp. 4).

Rosenberg (2001; cited in Engelbrecht, 2003) agreed, adding inadequate planning could result in short-term considerations of costs and ROI (return on investment) overshadowing the benefits in the longer-term (pp. 38). Therefore, they suggest an ML practice should also give due considerations to sustainability issues and include specifications for the strategic planning processes required to achieve this.

A review of ML frameworks

Many frameworks have been proposed for ML, some conceptual, some tested and validated. Evaluating them for effectiveness in a generic sense may be more difficult as suggested by Traxler (2007); the author finding many failed to consider pedagogy. Peng et al (2009) agreed, believing some frameworks are based on flawed definitions for ML and inaccurate representation of the concept. The authors argue some ML implementations lack the necessary characteristics which make them "*mobile*", suggesting they reflect a "*simplistic*" view of the concept (pp. 175).

Perhaps also as a result of the diverse nature of ML practices, the task of developing an evaluation process for establishing effectiveness and value added to learning for both ML process and any framework model for ML is therefore complicated (Taylor, 2006; Frohberg et al, 2009). The problem may also have a historical link with some of the issues already identified within e-learning embedding processes and technological integrations in learning. This provide a rationale for the look to evaluation practices of e-learning for solutions.

Well into the last decade, researchers and educators were concerned in much the same way about the lack of useful evaluation models for e-learning. Considerable investments have been expended in efforts to integrate e-learning into educational practices but there were no credible methods for obtaining evidences of value added to learning (Choy, Bell & Farrier, 2007). Justifying the need to create new tools and models for evaluating e-learning, Attwell (2006) asked how effective e-learning is and what (if any) returns there are on the investments into its integration. Attwell theorise existing evaluation practices were too focused on the technology, believing other "*socio-economic factors*" and other variables are being ignored (pp. 14); all of which may sound very familiar to ML proponents.

Many tried and true methodologies have been defined for benchmarking e-learning, providing a way to measure lagging, leading and learning indicators specific to the concept (Bacsich, 2005; Bacsich, 2009). The review of this thesis considers if perhaps e-learning benchmarking methodologies could be adapted for ML.

Selecting a benchmark methodology

In general, benchmarking provide means of comparing and analysing practices to obtain evidence of value added, performance and identify areas for improvement (Choy, 2007). A guide published by the Awwa Research Foundation gave a visual definition for benchmarking which itemised some of the components (see Figure 2.6; Brueck et al, 2003). Not surprisingly, e-learning benchmarking methodologies are several and varied, presenting some challenges in selecting a methodology to be adapted for ML (Attwell, 2006). Brueck et al (2003, pp. 4) theorised benchmarking may be categorised as follows:

1. ***Metric benchmarking:*** *Allows for quantitative and / or qualitative comparison of practices to track performance over time (Brueck et al, 2003).*
2. ***Process benchmarking:*** *Focus on mapping and evaluating processes to provide exemplar practices which may be emulated. Best used when outcome measurement is not possible or when it is to identify areas requiring improvement (Brueck et al, 2003; Bacsich, 2005).*

3. ***Practice benchmarking:*** *Evaluates practices with the aid of survey techniques; typical outcomes include "histogram profiles that reveal the extent to which participants use, engage, or benefit from a given set of business practices" (Brueck et al, 2003, pp. 4).*

Brueck et al, 2003; Bacsich, 2005

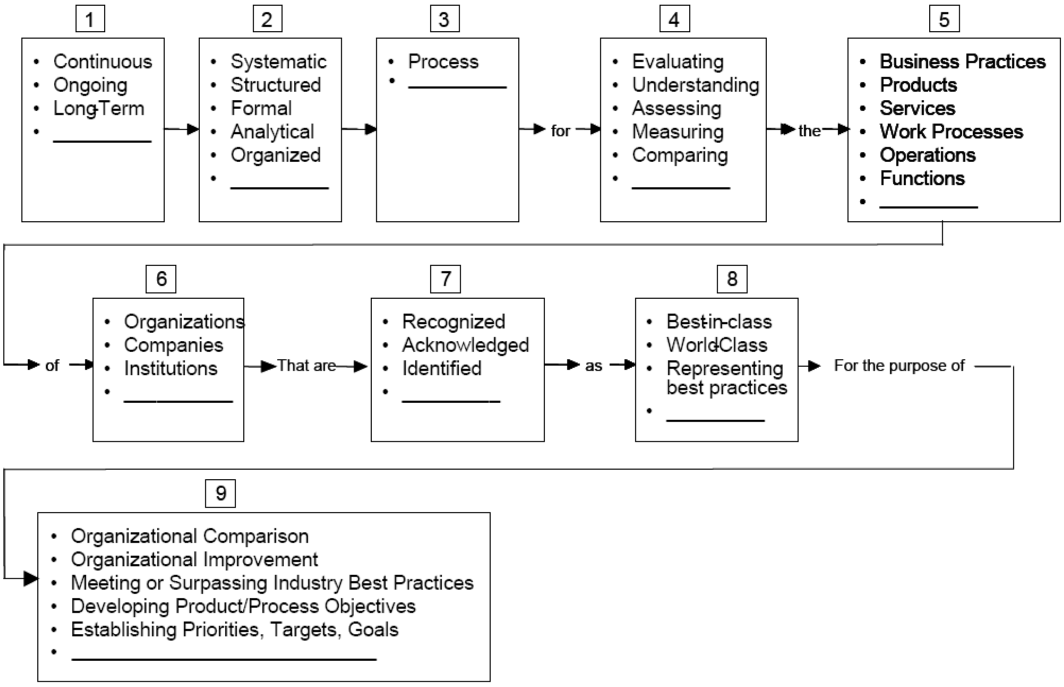


Figure 2.6: Options for defining benchmarking (Brueck et al, 2003)

Others categorised benchmarking into methodologies that are *implicit*, *independent* or *collaborative*, *internal*, *external*, *vertical*, *horizontal*, *input / process* or *output* focused, or those yielding *metric* values or general *information* about performance etc. (Professor Norman Jackson of HEA; cited in Bacsich, 2005, pp. 4-5). It is important to note that a suitable methodology may be several combinations of categories and it may be impossible to find one single solution that will measure all that is required. In fact Fetaji & Fetaji (2009) cautioned against creating a one-size-fits-all solution evaluation technique for e-learning. Therefore, the objective(s) of the measurement process will be important in selecting a methodology.

For evaluating ML practices or frameworks, important objectives may include establishing evidence of value added, ensuring optimum benefit to learning and achieving learning outcomes as well as how the process could be integrated and sustained over time. After interviews, focus group sessions, survey of "*e-learning specialists*" i.e. academics, staff and students as well as review of relevant literature, Fetaji & Fetaji (2009) derived 18 e-learning indicators (ELI) which is used here as a starting point for defining metrics for evaluating ML.

Table 2.5: E-learning benchmark indicators

	E-learning indicators (ELI)	Brief description	ML indicators
1.	Learner education background	Educational experiences and cultural background	Learners' background
2.	Computing skills level	Learners' and instructors' competency in using ICT	ICT / technology competency
3.	Type of learners	Learning style as formulated by Felder & Soloman (cited)	Learner types
4.	Their learning style and multiple intelligence	Learners' and instructors' styles preferences in learning	Learning and teaching preference
5.	Obstacles they face in e-learning (e-learning barriers)	Values for this may be subjective and environmental	Barriers and limitations
6.	Attention	Learners' ability to handle workload	Attention span
7.	Content (suitability, format preferences)	eContent with relation to format, suitability etc.	Content design
8.	Instructional design	Suitability for learners and achievement of learning outcome (includes pedagogical considerations)	Instructional design
9.	Organisational specifics	Organisational culture and policies in relation to e-learning integration; may include sustainability / monitoring plan, technology support, staff training	Organisational issues
10.	Preferences of e-learning logistics	Learners' and instructors' preferences for e-learning integration; may include classroom management measures	Preferences for MDT integration
11.	Preferences of e-learning design	Learners' and instructors' preferences for e-learning design; may include preference for location / context	Preferences for MDT design
12.	Technical capabilities available to respondents	Technical capabilities / skills gained through e-learning	Technical capabilities / availabilities
13.	Collaboration	Available collaboration streams with other institutions or e-learning providers	Collaboration stream availabilities
14.	Accessibility available to respondents	Available accessibility features and strategies	Accessibility and risk limitations
15.	Motivation	Learners' and instructors' motivations to participate in e-learning	Motivation to participate
16.	Attitudes and interest;	Learners' and instructors' attitude and interest relating to e-learning	Attitudes and interest
17.	Performance self-efficacy (the learner sense their effectiveness in e-learning environment)	Learners' and instructors' self-evaluation of competencies within an e-learning environment	Self-evaluation of competencies
18.	Learning outcomes	Learning outcomes and objectives to be achieved and / or enhanced in the e-learning environment	Learning outcomes

Source: Multi-dimensional model e-learning indicators – ELI (Fetaji & Fetaji, 2009, pp. 4-5)

The indicators seemed particularly relevant since they included items also explicitly or implicitly common in other e-learning benchmark methodologies (e.g. Pick & Mix approach, BENVIC – Benchmarking of Virtual Campuses, CHIRON). Crucially however, they were also tested in a case study involving two e-learning tools in two institutions for effectiveness. It is proposed this could be a useful process to apply to ML practices. Table 2.5 present the original indicators in ELI model; the last column containing suggestions of adaptations for ML.

For ELI, item 4 (*“type of learners”*) may be grouped into active / reflective, sensing / intuitive, visual / verbal and sequential / global according to Felder & Soloman’s (n.d.) model. Item 5 (*“… multiple intelligence”*) may be grouped into intellectual ability indicators as derived by Tomas Armstrong (n.d.) i.e.

- *linguistic intelligence ("word smart")*
- *logical / mathematical intelligence ("number / reasoning smart")*
- *spatial intelligence ("picture smart")*
- *bodily-kinesthetic intelligence ("body smart")*
- *musical intelligence ("music smart")*
- *interpersonal intelligence ("people smart")*
- *intrapersonal intelligence ("self smart")*
- *naturalist intelligence ("nature smart")*

(cited in Fetaji & Fetaji, 2009, pp. 4).

Benchmarking ML frameworks

Some of the indicators in Table 2.5 can also be applicable to ML while some are not. For instance, it may be irrelevant to determine learners’ “*multiple intelligence*” in an ML context, but preferences for learning modes may be essential. Some learners may also have preferences about what / how / when MDTs are used in learning as theorised by Shih (2005). MDT-specific characteristics such as *ubiquity* and *mobility* also need to be reflected as indicators for ML.

Table 2.6 presents indicators considered more relevant for evaluating practices involving the use of MDTs, categorised for greater clarity. They not only reflect and address issues specific to ML, but have been designed to also evaluate strategies for continuity. The indicators have been used to evaluate existing ML framework models to create the comparison table presented in Tables 1 and 2 in Appendix 14. Table 1 (Appendix 14) shows where each of the frameworks may have focused efforts and Table 2 (Appendix 14) provides a brief description and more relevant details on the models compared in Table 1 (Appendix 14).

Table 2.6: ML evaluation criteria and indicators

	ML indicators	Categories	Brief description
1	Tools and MDTs requirements	Mobile Device Technologies (MDTs) / infrastructures Consider for all users – staff, students and other stakeholders	How accurate is the estimation of users' requirement for tools and MDT; including cost, training and support necessary?
2	Access to MDT / technology		What is the extent of all users' accessibility to the wireless network and any enabling technologies?
3	MDT competency		What is the extent of all users' competence in MDT and ICT / other enabling technology use?
4	MDT preferences		How accurate is the estimation of users' preference(s) for devices, spaces and contexts?
5	Network integration and interoperability		What is the status of integration into the network and interoperability with other ICT technologies used for learning as necessary?
6	Learner types	MDT users: Staff (instructors and support staff) and students' Needs requirement analysis	What is the impact of learner types on activities selected e.g. individual / group?
7	Programme or study mode		What is the impact of mode of study on type of contexts / activities selected e.g. mainstream, online, distance etc?
8	Learning style & preferred learning & teaching mode		How well have the learners' and instructors' style and preferred learning and teaching mode informed activities?
9	Attitudes / privacy / ethical needs		How well have the learners' and instructors' attitude and preferences with relation to privacy and ethics been taken into consideration?
10	Content access / download preferences		Quality of ML content including format and suitability for both scheduled as well as offline / informal learning.
11	Training and support		Quality of training and support provided for MDT integration and usage.
12	MDT placement in the process	Instructional design in MDT-friendly environment / student-centered learning	Allowances made for the placement and integration of MDT in the learning process.
13	Learning objectives / outcomes		Allowances made to ensure the achievement or enhancement of the learning outcomes and objectives in the ML space.
14	Pedagogy		Suitability of pedagogic selection and exploitation of educational affordances of MDTs.
15	Control / role dynamics		How well changes in instructor / student roles have been managed?
16	Curriculum / learning / subject	Content & curriculum in MDT-friendly environment / student-centered learning	Quality of adaptations made to the learning process in line with the suitability of the curriculum / subjects for ML.
17	Content requirement analysis		Quality of analysis and provisions for ensuring both new and existing content have pedagogic underpinning and are optimised for multiple platforms and devices as necessary.
18	Content design, development and delivery		Quality of content design, development and delivery and suitability for selected delivery platforms (online, VLE, bespoke mobile application); including optimisation of content for multiple platforms.
19	Classroom / learning space requirements	The learning space for MDT-friendly environment / student-centered learning	Estimation of how well all learning spaces involved have been identified and how this informed the type of activities selected.
20	Learning space / context dynamics		How well has the dynamics within learning space and context and across spaces and contexts been managed to enable seamless learning interaction opportunities?
21	Implementation strategies	Institution / organisation's responsibilities Integration, sustainability and	Quality of coordinated implementation and awareness activities; institutionally driven and supported.
22	Evaluation and monitoring strategies		Quality of research and practice informed evaluation and monitoring strategies.
23	Organisation and policies		Quality of management of culture and policies

	ML indicators	Categories	Brief description
		governance	changes' change management across learning establishment.
24	Managing expectations		How well has expectations been managed and executed?
25	Managing competitive advantage		What are the strategies for exploitation of usage for competitive advantage and how well has these strategies been managed?
26	Motivation to participate		How well has the motivation of staff and students been managed and encouraged?
27	Students	Risk analysis and management Analysis of risk and impact as relevant	How effective are the risk analysis and mitigating strategies implemented for all stakeholders (staff, students, the institution / organisation), the curriculum, learning MDT technologies as well as enabling platforms and applications?
28	Instructors		
29	Institutions / organisation		
30	Curriculum		
31	Learning		
32	MDT / platforms / applications		

It is important to remember these indicators are not intended as a comprehensive list of indicators for ML but may provide a starting point for evaluating practices and frameworks within the domain for ongoing effectiveness and sustainability. The categories in Table 2.6 will later be mapped to goals and requirements collated from the findings from the review of this thesis and other sources to create system models for ML in Chapter 7.

Limitation of the evaluation methodology and comparison

The indicators represent currently identified issues in the practice of ML, informed by lessons learnt from e-learning adoption, integration and sustenance. Therefore, the list of indicators may have excluded issues yet to be identified or included those that may have now become obsolete, perhaps due to advances in MDT development. However, the indicators are scalable and therefore, components may be included / excluded as necessary.

Another potential limitation concerns the documentation available at the time the comparison table was created. It is possible some pertinent details about the frameworks not included in documentations have not been taken into account. Some frameworks may also have been excluded from the table because documentations for them are unavailable. Also, while the table may indicate what's missing, it is not possible to reflect the depth or level to which each metric may have been satisfied. Where it is necessary to establish the degree to which each indicator has succeeded or failed, another level of dimension will be required within the evaluation methodology.

In addition, there may be legitimate reasons why some aspects may have been excluded from some of the frameworks or ignored, perhaps because that was not really the objective of the process or these aspects were irrelevant in that particular instance (e.g. the Puentedura's SAMR model and the framework for prioritising ethical issues). The comparison matrix may have failed to highlight these circumstances, and perhaps in that sense, there may be some unfairness in a comparison metrics using a standard set of indicators.

However, the Puentedura's SAMR model for instance claims to be "*gaining traction … as a holistic method of combining technology, content and pedagogy*" for ML projects. Bearing this objective in mind, it seems only fair to highlight aspects of 'combining technology, content and pedagogy' that may have been excluded (Belshaw, 2010, pp. 24). It is also anticipated comparison metric tables such as those in Appendix 14, reflecting the main focus of the models may be useful in selection processes.

Table 2 in Appendix 14 provided more details about which of the frameworks have been tested for effectiveness as the documentation reviewed revealed. However, the findings of the tests (where relevant) have been omitted and are beyond the scope of the review of this thesis. Also, the comparison is focused solely on what is reflected within the components of the frameworks and not on the trials. For instance, while some of the trials or subsequent documentation may have reflected some considerations for some of these indicators (e.g. learning objectives or pedagogy), the analysis will only record a tick against an indicator if it is explicitly represented within the framework components / elements; on the basis that precise level of granularity matching objectives is necessary for clarity.

2.4. Making a case for ML in education

There are many suggestions for the use of MDTs in literature; many theoretical and many more presented in experimental trials; some already outlined in previous sections. As a start, MDT is believed to offer some potential advantage for hard-to-reach learners, presenting an opportunity to reach them on their own terms (Traxler, 2007; Brett, 2008; Ally, Attewell et al, 2009; Traxler, 2011). This has been recognised in several projects such as a European funded ML implementation studying how to reach unemployed 16 to 24 year old youths who have refused to remain in education in an early example of a BYOD scheme (Clyde, 2004).

More recently, UNESCO started several ML initiatives across Africa and the Middle East, Asia, Europe, Latin America and North America, begun since 2012. Working with "*governments and other stakeholders*", the projects highlight good practices of MDT uses in learning. A report of activities across Europe outlined several EU and government funded projects including MOBIlearn and MoLeNET, concluding the future is uncertain for ML and would largely depend on government policies (UNESCO, n.d.; Hylén, 2012).

Mobile devices have also been used to encourage learning within whole communities which included parents and other family members of the targeted learners in rural areas (Kim, Taylor, Wang et al, 2009). Another school of thought believe SMS or MMS affordabilities may add transformative dimensions to learning processes and administrations when used with due consideration for the achievement of learning objectives (Attewell et al, 2009). MDT affordances are believed to be capable of facilitating asynchronous communications between tutors and groups of (or individual) learners, either within a classroom setting or outside of scheduled instruction hours (Brett, 2008; Casany et al, 2012).

A similar system was presented in ESCalate publication involving the simulation of a flood disaster system (Cornelius et al, 2011, pp. 13-17). SMS messaging can be useful for facilitating role-playing scenarios, as was the case in this instance, to encourage decision making. They allow provision of tailor-made feedback support or relevant responses in a timely manner to achieve learning objectives. They may also be useful for supporting learners who may be struggling and perhaps unable or unwilling to communicate difficulties verbally in the classroom; allowing scaffolded learning (Chen et al, 2008; Wishart, 2013; Abdullah et al, 2013). Learners have the choice of seeking face-to-face meetings with tutors or seeking support through such systems and on their own terms (McMullan, 2008; Kim, Wang et al, 2009).

Wang et al (2009) found SMS / texting affordance of MDT especially useful in an experimental trial with Chinese students, where students were unable or unwilling to seek face-to-face support from their tutors due to cultural constraints. Students typically prefer to study alone, and are reticent of initiating meetings with instructors. The publication reported many of the students would much rather prefer to listen to audio recordings of their instructors rather than attending sessions and / or interacting with them in person.

Just-in-time learning delivery is also proving to be of immense benefit to students still, potentially providing students with content at just the right time anytime and anywhere. Those owning tablet PCs can access any type of content such as question banks uploaded onto web-based platform and made available for download and installation through apps or other systems on learners' devices. This can subsequently be used as formative assessment. Web-based self-assessment systems can also provide access to assessment activities that may help prepare them for summative assessments or to reinforce their knowledge (Arreymbi & Draganova, Lee et al, 2008; Olasoji & Draganova; 2010).

Another potential motivation lies in the need to provide students with the necessary skills needed to thrive and succeed in an increasingly competitive employment market (Youatt & Wilcox, 2008). The IPPR's report stated there is professional and trade skills shortage which the report attribute in part to "*increasingly complex technology*" (IPPR, 2013, pp. 45). Aoun (2014) agrees, suggesting skilled graduates with the capacity to fulfil increasingly advance set of technological expertise required by the employment market are lacking globally. The author advocates provision of optional programmes accessible through MDTs and "*competency-based approaches*" to learning in HE, along with "*partnerships with employers*".

2.4.1. Opportunities in educational affordances of MDTs

Affordances or lack of, as the case may be, in any technology can be both an advantage and disadvantage. Gibson (1977; cited in Lai et al, 2007) describe *educational affordance* as "*characteristics of an artefact that determine if and* *how a particular learning behaviour could possibly take place within a given context*". This may be in the form of rapid access to real-time content as well as facilities for note-taking and reflections which include images, sound and video (Lai et al, 2007). Others include location / context aware services and GPS etc.

There is no doubt increasingly convergence nature of MDT is presenting unique possibilities. Where several unconnected devices may have been needed before for a particular task or activity, a multi-device converged MDT may be capable if filling all the roles required in a seamless process. However, Lai et al (2007) warned learners may lack the necessary skills to take advantage of these features and this is more applicable today as devices become even more sophisticated and complicated to use. Dunleavy et al (2007) agreed adding educators may also lack skills required for effective facilitation of ML processes (Dunleavy et al, 2007).

McLoughlin & Lee (2008) support the idea of taking advantage of educational affordances in mobile devices, but offer a different view on learners' skills. The authors argue learners are in fact able to select suitable technologies to meet their needs and capable of utilising the features and capabilities present to their advantage in learning processes. Today's learners, they maintain, live in a culture where there is a blurring between learning, working and playing. They also have exposure to wide array of Web 2.0 technologies and tools as well as mobile computing and "always-on" connectivity (McLoughlin & Lee, 2008, pp. 10).

This seems to correlate with the findings of Corlett et al (2005) during a trial with 17 MSc students at the University of Birmingham in 2002 / 2003. They found the students, though initially lacking knowledge on how to use many of the features on the PDAs used in the trial were not uncomfortable getting accustomed to using the devices. It may be relevant to note this particular trial issued the same PDA to all the students, and consequently with the same affordances and features.

In a BYOD environment that seems common in HEIs currently, it could be difficult for the facilitator to support all students effectively, especially in large cohort groups, if they have problems using any of the affordances required for a task on their own devices. It is believed learners can often cope given adequate time to develop the skills necessary (Nerantzi et al, 2014). It has also been suggested there may be inequality due to varying competencies; perhaps not unlike learning itself which may be subject to varying innate skills and abilities (Sarrab et al, 2012).

Thus, McLoughlin & Lee (2008) agreed with Dunleavy et al (2007) on the need for educators to gain some skills in supporting and utilising any of the technology they plan to integrate successfully in learning contexts. The authors suggest there could be a '*culture shock or skills crisis*' when educators of the 'old school' have to work with unfamiliar technologies and learning spaces. The suggestion is they may lack skills required to use the technologies effectively. The inability to use these tools effectively and consequently facilitate their use in the learning process the authors theorise, may lead to lack of confidence, and possibly failure to achieve learning objectives (pp. 19; Kukulska-Hulme, 2010).

2.4.2. The conundrum of mobile "deep" learning

Briefly considered in Section 1.3.1, this concept will be explored in more depth in this section. Mention of "deep learning" in the same context as some of the current uses of MDT has been judged an untapped potential at best by skeptics, concerned it is primarily used as a tool for accessing learning content, perhaps on a VLE or other online platforms (Valcke, 2011; Abdullah et al, 2013). Also, MDTs are multi-functional devices with primary features for communication and entertainment often taking precedence over learning uses. A member of a university governing board made the following comments in reference to the notion of MDT's ability to help students make better use of "idle time" or learning when mobile:

> *"I do find it amazing that everyone around you on the train or everywhere have their heads in a sort of mobile device or the other. The question however is: Is this communication really necessary? Are you communicating something important or is that using up the time [idle time] … because there was nothing better to do? And while there's nothing wrong with that per se, you might ask if engagement in such a manner is deep or superficial."*

Availability of tPCs capable of accessing generic content may have changed some opinions on the matter of recent. Be that as it may, it has often been suggested students could adopt deep, surface or strategic approaches to their learning (McKimm, 2002). For an academic, tutor or learning facilitator, moving students from surface or strategic approaches to deep learning; thereby encouraging critical thinking, meaningful construction and associations beyond simple assimilation of information is assumed a desired objective.

Kukulska-Hulme (2010) agree with this assumption, viewing the issue from another perspective and identifying "*learner skills, attributes and competences*" required by today's learners as follows (pp. 6):

- Active, inquiring, analytical
- Engaged citizens
- Equipped with research and inquiry skills
- Exercise independent critical judgment
- Co-creators and producers of knowledge
- Able to function effectively in the real world
- Able to communicate and cross language boundaries or cultural boundaries
- Motivated and equipped to continue learning over a lifetime

The author agree "*many educators aspire to use new technologies in ways that will enable such competences*" as listed above (and illustrated in Figure 5.2), posing question not unlike those considered in this section: Can MDT integration in learning and teaching aid the achievement of these attributes? The author conclude it is possible, adding "*mobility, awareness of context, and learners' specific needs*" are great motivators for using MDTs. However, Kukulska-Hulme (2010) noted there needed to be "*more explicit mapping between what is expected of learners and how mobile technology can help realize these goals*" (pp. 11).

Dick and Carey's instructional design model located '*develop & select instructional materials and tools*', which may or may not include MDTs, after the development of instructional strategies (see Figure 2.7). There are suggestions this step is sometimes executed too early; with learning processes built around MDTs (Peng et al, 2009). Also contributory is perceptions of MDT's core functions as a "quick access" tool. Suggesting positives for MDT integration in learning, McLoughlin & Lee (2008) stated it could aid "short burst" information access and multi-tasking, believed to be characteristic practices of today's learners. This affordance however gives the impression of limited engagement as theorised by Valcke (2009).

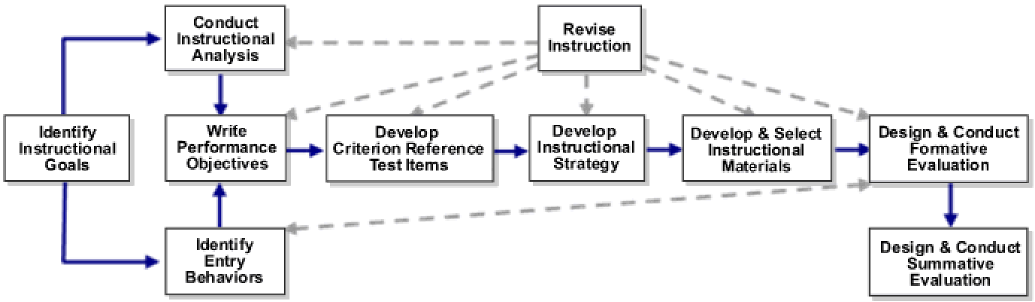


Figure 2.7: Dick & Carey's instructional design model (Source: Penn State (n.d.)

In a keynote presentation, Valcke (2009) suggested MDTs may be unable to give full meaning to words and pictures, nor are they able to provide adequate interactivity and manipulation required for learning to take place. "*Learning is art, but not fun*", he stated, suggesting there is a playful element to the use of MDT. The same issue was considered at a workshop organised as part of the ML theme of the Kaleidoscope European Network of Excellence in Technology Enhanced Learning titled 'Big Issues in Mobile Learning'. One of the interesting conclusions reached is "*ML is not just about learning using portable devices*", adding "*ML is not something that people do; learning is what people do*" (Sharples et al, 2006, pp. 3).

Duncan-Howell & Lee (2007) are on the other hand of the opinion current learners demand (or require) learning that is flexible and readily available wherever they may be, with an expectation of technological integration. Peng et al (2009) and Liu et al (2009) agree, the latter also identifying some of the characteristics of the type of *learning* that can take place "*all around*" students wherever they may be when MDT is used effectively (pp. 161). These are seen not only enabling learners to realise their learning objectives, but offering opportunities to develop problem solving skills; improving their mode of inquiry and exploration of new information.

Miettinen 2000 suggest MDT may provide a way to overcome some of the criticisms of experiential learning theories. Two of the major flaws of particular interest have been identified as lack of "*mechanism for focusing awareness in the learning context*" (McMullan & Cahoon, 1979; cited in Lai et al, 2007, pp. 327) and Vince (1998) suggests there is the belief "*students pay insufficient attention to abstracting from experience*" (cited in Lai et al, 2007, pp. 327). Lai et al (2007) evaluated the use of wireless and MDTs in experiential learning processes, finding technologies offer features and capabilities, termed "*educational affordances*", that could encourage knowledge creation and construction (pp. 328).

Therefore, while there may be no immediate learning gain, they conclude MDTs can enhance learning in experiential learning processes and could be more effective in achieving learning objectives. Worthy of note is the reliance on MDT features for *educational affordances*. As mentioned earlier, given the variety and non-uniformity in operational modes of MDT features that may be present in a BYOD environment, this may be problematic.

2.4.3. Differentiating attributes of ML processes

In Section 2.3.1, the quest for a consensus on a definition for ML was considered and a few of those proposed reviewed. The previous section (2.4.2) also deliberated on whether MDT is capable of facilitating deep learning. An important consideration in literature offered as one of the barriers for ML relates to problems quantifying the value MDT adds to a learning process; and in particular, the necessity to establish its value above other technologies (Frohberg et al, 2009). In other words, what is unique about an ML process? What are the values that can only be added to a learning process through the use of MDT? It may be clear many of the existing definitions have not gone far enough to differentiate ML from other types learning such as e-learning.

A learning technologist colleague in HE commented to the researcher: "*I can't think of something you can do with the mobile that you can't necessarily do with something else*". From observations and findings from the review of this thesis, this statement seem to encapsulate the feelings of many in educational community, perhaps supporting the need for differentiation to move the agenda forward for ML. Kukulska-Hulme (2010) agreed, stating MDT is "*underused*" in learning and surmising the reason may be "*due to unresolved issues in the use of mobile devices for informal teacher-learner communication when classes take place in a formal setting*" (pp. 5).

Kukulska-Hulme (2010) went on to list some of those "unresolved issues" as "privacy, information overload, prohibition of use in some establishments, and a lack of trusted guidelines on acceptable conduct" (pp. 5). The author added growing ownership among students is however a big motivation for continuing interest. ML sometimes suffer from a description in relation to the educational system, believed to be "very poorly adapted" to the world we live in and the social transformation occurring within it, suggested an academic who adds:

> *"It [ML] is not really a version of learning or a subset of learning … it is actually learning transformation … transforming the basis on which we know things, learn things and the world in which we live. And the fact that we then use technology to access or change our ideas about the nature of the world is kind of secondary."*

While these sentiments may express an ideal scenario for learning, all efforts till now has done very little to sustain MDT use (Wingkvist, 2009; cited in Petterson & Vogel, 2012; Rajasingham, 2010) or differentiate the process of ML. Section 2.4.2 lists competencies desired for today's learners as suggested by Kukulska-Hulme (2010), leading to contemplations of how MDT may help achieve them. A closer look at these competencies may reveal they can also be achieved in a well thought out traditional learning process or perhaps a TEL / e-leaning process, (Choy, Bell & Farrier, 2007). It may be assumed this could be contributory to the lack of enthusiastic support for MDT use.

Therefore, it is clear there may be a need to highlight other attributes / benefits of ML process to differentiate it from other types; and these may include those extracted from definitions explored in Section 2.3 as follows:

- **Ubiquity** ... of the technologies involved, suggesting the process can occur anywhere and at anytime
- **Mobility** ... of the learner, learning, technologies involved and the learning space etc.

- **Affordance** ... offered by the technologies involved
- **Learning** ... aims and objectives to be achieved
- **Pedagogy** ... for achieving the objectives of the learning

In the strictest sense, only two may be needed to differentiate ML from other types of learning as suggested by Peng et al (2009) and these are *mobility* and *ubiquity*. Other researchers such as Traxler (2007), Looi et al, Rajasingham, (2010), Cruz et al (2012) etc., agree in principle. With mobility and ubiquity, learning is not bound by time or space and can occur wherever the learner is. Hence, the learning is transformed into a flexible, just-in-time process.

Table 2.7: Comparison between ML and e-learning

Content attributes	Outcome attributes
e-learning (electronic learning)	
Ready access	Skilful making interdisciplinary connections
Vast libraries of repositories	Trace history of ideas & evolution of thought
Immersion multimedia	Apply theory to primary texts
m-learning (ML)	
Portable, interactive	Situated problem-solving
Limited media	Able to integrate multiple content sources
Gather data	Create “map”
Integrated prior knowledge	Develop tangible “solution” as outcome

Constructed and reproduced from Nash, 2007, pp. 813

Rajasingham (2010) also added mobility is the main difference between a potentially “*fluid ML*” session and a “*tethered e-learning*” process (Traxler, 2007; cited in Rajasingham, 2010, pp. 3). The author went on to add *ownership* and *informality* as other important differentiating attributes (pp. 4). Laouris & Eteokleous (2005 pp. 3; cited in Nash, 2007) added yet more attributes: *spontaneous*, *intimate*, *situated*, *connected*, *lightweight*, *personal*; while Nash (2007) compared content and outcome attributes of ML and e-learning as shown in Table 2.7.

However, the list of competencies desired for today’s learners as proposed by Kukulska-Hulme (2010) would suggest *mobility* and *ubiquity* alone cannot make an ML process self-sufficient in meeting learners’ needs. There must be a relationship between the two attributes and others identifiable in a learning process. It is also important they are considered in the context of how they might achieve *learning objectives* (Corlett, JISC, Vavoula, 2005; Peng et al, 2009; Belshaw, Koole et al, Looi et al, Lucking et al, 2010).

Traxler (2011) suggested ML contexts should ensure “learners can react and respond to their environment and … learning and teaching opportunities are no longer pre-determined beforehand”. Examples suggested by the author include religious studies during visits to churches and temples or history during visits to the museum (pp. 6). Given this premise therefore, a derived working definition for ML may be stated as follows:

> *“A form of learning in mobile and ubiquitous contexts and spaces, which benefits from educational affordances present in the MDTs involved when underpinned by sound pedagogical principles and resulting in the achievement of the learning objectives set.”*

This may present a nightmare scenario in the current traditional modes of curriculum-controlled, lesson-planning, semester-oriented learning culture. In such environments, the suggestion by Kukulska-Hulme (2010) is for a mapping between goals and learning expectations as a matter of necessity. It is accepted this definition proposition may have the unintended result of adding yet another one into the mix of existing variations. Nonetheless, it was deemed necessary to highlight the necessity for differentiation or at the very least engender a debate on the issue, anticipated and highlighted perhaps through its development.

2.5. Review summary

In this chapter, a review of literature on the precise placement of MDT in learning was presented along with considerations for its limitation(s), past and present, potential for deep learning and the opportunities offered in educational affordances. The review also included an account of citation analysis and systematic analysis review of relevant publications conducted as part of the literature review for this thesis, as well as indicators for evaluating ML frameworks and practices. While these reviews and indicators are not without limitations they provide a useful snapshot of the state of the art of ML and the placement of MDT in learning.

It is clear considerations regarding MDT's capability to support or facilitate "deep learning" as well as theoretical understand of the domain of ML will continue to affect its progress. Review of existing literature revealed some of the muddled thinking around the concept; to be explored later in the responses of participants to the review of this thesis. One thing clear from proposed definitions is they do help identify key attributes of an ML process. As an academic stated: "*We don't ask for a definition for e-learning anymore; yet we recognise an e-learning process when we see one.*" Perhaps that's a good starting point for ML as a concept or domain i.e. that it is at least recognisable, and value added to learning proven / accepted in implementations.

Chapter 3

Research serves to make building stones out of stumbling blocks.

~ Arthur D. Little

The study schema: A discourse on research methodology

3.1. Design, rationale and methods

The gap between theoretical understanding and the practice of Mobile Learning (ML) as well as attempts to establish a relationship between Mobile Device Technologies (MDTs) and education provided a background for this research. Some of these issues have been discussed at some length in the previous chapters. In Chapter 1, it was also suggested there is a need for a different approach to the problem, such as a look to computing techniques capable of analysing requirements in the discipline of Requirement Engineering (RE).

While RE as a discipline is domain neutral, its techniques for requirement analysis and goal-oriented modelling have been used in computing and software engineering for several years to derive user specifications for a product and align organisational goals. RE is a relatively new subject discipline with many authors describing it as the same as requirement analysis while others believe it is much more. For instance, Berenbach et al (2009) suggests it also involves the process of deriving and documenting requirements for the effective development or improvement of a system, tasks which are not normally part of a requirement analysis process.

These attributes are most beneficial to the review of this thesis. A preliminary review of literature found several interesting paths could potentially be explored in order to fully address the research question. RE techniques provided a way of exploring as many of these paths as possible while deriving conceptual models for a more sustainable relationship in future between MDTs and education. This process is examined in more depth in Chapter 7 using methodologies employed in Agent Oriented Software Engineering (AOSE); another requirement analysis discipline, utilised in conjunction with RE goal modelling techniques.

Thus, Chapter 4 presents a rationale for the use of RE by exploring the stages and some of the techniques that may be useful to the review of this thesis while strategies employed in data collection process for the research are outlined in this chapter, followed by a discourse on the philosophical perspectives and assumptions guiding the research. Issues relating to ethics and trustworthiness are also considered. A mixed of methods comprising of quantitative and qualitative approaches have been utilised along with modelling techniques; playing a crucial role in maintaining rigour in the research process.

It is commonly accepted mixed methods approach can help overcome drawbacks in favouring one methodology over another (Creswell, 2003; Cameron, 2009; Cronholm & Hjalmarsson, 2011). Although Jones & Bartlett (n.d.) outlined opposing views to this premise, suggesting research methods should be selected primarily to compliment the questions or issues under investigation, the variation in methodologies employed were found to be useful in the review of this thesis.

3.2. Research parameters

The educational system in the United Kingdom comprises of 5 main levels:

1. Early years or nursery education
2. Primary education
3. Secondary education
4. Further education (FE)
5. Higher Education (HE).

The review of this thesis was conducted in UK university (HE) environment. However, observations and some primary and secondary data were available to the review for comparison, from secondary and further education students and practitioners.

3.2.1. Research questions and inquiry direction

The review of this thesis is aimed at gaining a full understand of the nature of current relationship between MDTs and UK educational practices. Therefore, the main question for the review is:

To what extent has ML using MDTs been integrated in learning and teaching in higher education since its conception?

To set a framework for answering this question, more questions are required as guiding principles and for exploring specific strands relating to educational practices in UK HEIs. Therefore the following sub-questions were proposed:

1. How can we theoretically understand ML as a concept?
    a. *What are the pedagogical issues in implementing ML processes for adult learners?*
    b. *How do educators' perceptions of the concept of ML affect adoption and integration of MDTs in their teaching practice?*
2. What factors affect the adoption and integration of MDTs in educational processes and the implementation of ML processes?
    a. *What are the current methods / approaches of adoption and integration of MDTs in learning and teaching and implementation of ML processes?*
    b. *What are the requirements for the adoption and integration of MDTs in learning and teaching, and ML processes.*
3. What are the effects of MDTs on the practice of ML and on the progression of learning and teaching in HEIs?
    a. *How effective are the current learning and teaching practices of ML and the adoption and integration of MDTs in educational processes?*
    b. *How effective are the current learning contents and instructional materials for ML and MDTs in educational processes?*
4. How can theory be applied to ML processes through the adoption and integration of MDTs in educational processes?
    a. *How can abstraction modelling techniques of RE and AOSE inform adoption and integration of MDTs in educational processes?*
    b. How do educators' practices regarding ML and MDTs adoption and integration affect learners' use of MDTs in their learning?

As the review of this thesis progressed and existing literature are explored, it became apparent there were other related strands requiring consideration. Rapid changes in the understanding of what may be classified as MDT during the course of the review also contributed to this necessity. Therefore, the following questions were subsequently proposed:

Several HEIs have prioritised provision of robust wireless networks, BYOD policies to support a myriad of MDTs and / or free issue of tablet PCs to students; most commonly new enrolees. Yet, ML itself is in decline (see Figure 1.1).

1. ***What are the evidences supporting the effectiveness of HEIs' integration approaches and the promotion of ML?***
    a. Is HEI's approach in integration of ML using MDTs in learning and teaching the best way to address the issues?

Evolution relationship between educational entities and MDT advancements seem in one direction; with technology driving development and appropriation in education.

2. ***What is the nature of the evolution relationship between education and MDTs in a learning process?***
    a. How might adoption and integration of MDTs in learning and teaching be impacted if education was driving progression and advances in the manufacture of MDTs?

Finally, the student body is made up of several sub-communities and categories of students, identified by the discipline they choose to study, level etc. Among these are future educators or pre-service tutors. These have the potentials to become change agents and carry out practices modelled for them in their own practices. Another track for the review of this thesis therefore is to conduct an investigation into educational practices among pre-service tutors as future educators. This study was inspired by the questions asked in the call for proposals for the research track of the UNESCO Mobile Learning week held on 17-21 February 2014 in France (UNESCO, 2013). The following are the sub-questions guiding this strand of the review:

1. How are educators trained to utilise new technologies to improve teaching and learning?
2. How are training institutions ensuring that pre- and in-service teachers receive adequate and ongoing training about ML?
3. How do the adoption and integration of MDTs build the capacities of teachers and support their work with students?

Seeking to answer these questions, data was collected from several stakeholders in HE who are educators (HE academics and pre-service tutors), students, those in the role of learning support and governance as well as MDT manufacturers / marketers and policy makers in universities and in the community.

3.2.2. Scope and boundary parameters

The quantitative survey was administered online and opened to all educational institutions: schools, secondary, further and higher educational institutions to provide initial grounding direction for the research. Subsequently, the review of this thesis was concentrated on teaching and learning as well as strategic policies / governance in Higher Educational Institutions (HEIs) in the UK.

In the initial design, two of UK’s HEIs were selected for case study review. Due to subsequent logistical problems relating to access and participation in one of the institutions selected, this plan was revised to conduct in-depth study in one HEI instead. To provide alternative views and robustness for the review of this thesis, secondary data was sought from other UK HEIs, statistical data repositories, publications from online databases etc., as well as websites belonging to the government, private and public organisations.

Participants were selected based on their relationship to HEI in the UK and / or the subject domain of education, ML and the use of MDT in education for the most part. However, there were views from other sources, obtained primarily for rigour and robustness as will be discussed further in this chapter.

3.2.3. Terms and usage contexts

A few specific terms and expressions are used in this review that may be associated specifically to the United Kingdom (UK) where this research is based. The context and use of these terms may not be clearly understood in other countries and are therefore clarified in the following sections.

Higher education or higher educational institution

Higher education or HE is UK's highest level of education in the post-compulsory educational sectors. Compulsory educational sectors in the UK include schools (primary and secondary). Higher educational institution or HEI refers to an institution in the higher educational sector, also known as universities.

An HEI offer academic pursuits leading to undergraduate (Diplomas and Bachelors) and postgraduate (Masters and Doctorate) degree qualifications. They may also offer short courses leading to partial or professional qualifications.

Higher education funding council for England (HEFCE)

According to the information available to the public on the HEFCE website (http://www.hefce.ac.uk/about/), "*HEFCE distributes public money for higher education to universities and colleges in England, and ensures that this money is used to deliver the greatest benefit to students and the wider public*". Understanding HEFCE's funding strategies was therefore crucial to gaining an understanding on learning as well as strategic priorities in HE.

Higher education governance

Higher educational governance refers to governing bodies in the higher educational institutions under the review of this thesis, including management staff as well as policy makers and developers. Governance of higher educational institutions may also be referred to as the Vice Chancellor's Group (VCG) and may belong to the Board of Directors of that institution.

Although the phrase is used primarily in the context of higher education, it may also refer to governance in other levels of UK's educational system. Data from members of these group of stakeholders were found to be important in the review of this thesis.

Academics / Educators / Tutors / Lecturers

These terms can be used interchangeably in the review of this thesis to refer to academics or educators in Higher Educational Institutions (HEIs) who carry out teaching and learning duties. In other countries or learning establishments, academics or educators may also be referred to as instructors or facilitators in descriptive terms. Academics / educators may include course programme or module leaders or course team leaders in certain cases.

Learning and teaching Vs teaching and learning

The terms "learning and teaching" and "teaching and learning" can also be used interchangeably in the review of this thesis to refer to the process of learning and of teaching learners in formal classroom settings or otherwise; including implicit references to the known characteristics of the process and strategies employed within the process to achieve learning aims and objectives.

3.3. Philosophical perspective

The review of this thesis has been driven by several assumptions and underpinned by two major research methodology paradigms briefly outlined in this section. The first paradigm can be explained in the words of Remenyi et al

(1998, pp. 33; cited in Holden & Lynch, 2004) which holds the view a researcher can be "*independent of and neither affects nor is affected by*" the research subject or domain (pp. 406). The *positivist paradigm* holds general beliefs and assumptions which can be categorised as follows:

- Real world objects can be known individually from humans (realist ontology).
- This reality can be known and represented using accurate descriptive symbols (representational epistemology).

(Cohen & Crabtree, 2006)

Also called the scientific method, the paradigm believes carefully chosen research methods used in the right way can lead the researcher to the truth i.e. the objective reality. The process involves observation and gathering of data, analysing the data for patterns indicating cause and effect using scientific or statistical methods, deriving a hypothesis to test a theory, conducting the stud(ies) to test the hypothesis and deciding whether the result supports the theory or not. Conclusions derived can be used to predict and control natural phenomenon in the 'real world'.

One of the major criticisms of the positivist paradigm is the assumption that experimentation or sampling can predict what occurs in reality. Kaboub (2008) would suggest while "*the results obtained … provide valuable insights into the nature of the reality, those results may lack external validity*" (pp. 343). Kaboub (2008) added the external world often presents underlying social problems that are far too complex to be perceived outside of it. "*Positivist prescriptions*", it is believed, "*tend to treat the symptoms rather than the root cause of the problem*" (pp. 343).

To be rigorous, a research based on the positivist paradigm must be evaluated by three main criteria: validity, reliability and generalisation (Cohen & Crabtree, 2006). Consequently, positivist researchers typically employed experimentation and / or quantitative methods. Those with preference for positivist approaches have often maintained some of its research methods, such as case studies and action research, could also be subjective with some room for interpretation (Holden & Lynch, 2004).

However, statistical methods used in analysis tend to produced generalised results and conclusions; characteristically requiring sufficient sample size to be representative of the population under the stud(ies). This allows very little room for contextual and in depth studies. Given this critical flaw, there was a need to consider other approaches in order to fully understand the problems.

The *interpretivist paradigm* is an alternative approach which holds the belief the researcher and research subject are closely linked. Also termed "phenomenology" or described as social science or subjective approach, this school of thought can be categorised as follows:

- Our reality is developed and constructed "*through the meanings and understandings*" from our social experiences (relativist ontology).
- The researcher cannot be separated from what he or she knows; and consequently, the researcher and the object of research "*are linked such that who we are and how we understand the world is a central part of how we understand ourselves, others and the world*" (transactional or subjectivist epistemology).

(Cohen & Crabtree, 2006)

The interpretivist approach holds the view there are multiple perspectives about a distinctive event which cannot be generalised. The researcher is often expected to interact with the research subject and "*are driven by own interests, beliefs, skills and values*" (Holden & Lynch, 2004, pp. 405). Qualitative methods of i.e. interviews, observations and existing texts analysis, are therefore required to make some sense of the subjects' experiences, interpretation and meanings perceived from events.

Consequently, answers are found in dialogue-based inquiry which may arise from analysis of opposing or similar viewpoints and opinions from typically a small sample of members within the research domain environment. Values and personally developed concepts and thought processes become part of the truth and findings emerging from the research process and interpretations are only descriptive of an exact situation, context or moment in time; often unsuitable for generalisation purposes.

The individuals involved within different groups of stakeholders hold different or similar interpretation of the aspects involved in the research. These are in turn open to subjective interpretation and further negotiations throughout the dialog. It implies crucially, that a close relationship must be forged between the researcher and the research participants for the process to succeed. Understanding can only be gained from the strength and dynamics within this relationship and the environment in which the conversational dialog occurs (Shenton, 2004). Participants share their opinions from experiences, meanings and interpretations with the researcher; who in turn would derive some patterns and conclusions from the data collected (Holden & Lynch, 2004).

Another valuable characteristic of the review of this thesis can be understood based on the beliefs of those of the interpretivist persuasion. The paradigm takes into consideration the fact that the researcher's understanding, knowledge and viewpoint regarding the subject domain will have some bearing on the whole process from data gathering, collection and analysis to findings and results presentation (Mack, 2010). The researcher can only observe the nuances and arrive at the "truth" from *inside*, and sometimes as an active participant.

As a member of the organisation being studied in the role of learning support and governance, the researcher is both a participant as well as a researcher within the environment being studied: a higher education institution. Therefore, the review of this thesis is conducted from an "*insider's perspective*" (Jones & Bartlett Learning, n.d., pp. 47).

Outlined in Chapter 2, a review of literature has shown there are some degree of fuzziness and confusion still in the domain of ML and the integration of MDTs in education. Understanding and explaining the phenomenon and the dynamics at play therefore required these mixed methods of approaches. Quantitative methods provided some statistical values by which the concepts and facts obtained can be quantified and compared. Qualitative approaches helped in understanding contexts, identifying emerging trends and deriving guidelines to guide future relationships.

Methodologies from interpretivist persuasion were especially crucial in the review of this thesis because “*the research context or the nature of the problem is poorly understood*” (Jones & Bartlett Learning, n.d., pp. 46; Frohberg et al, 2009). The researcher’s position and role in this process was also essential to the success of the research, as will be clarified in the next section.

3.3.1. The role of the researcher

The importance of the role of the researcher, as well as the relationship between the researcher and the participants have been mentioned briefly in the previous section. Having sole responsibility for conducting the review of this thesis, it was essential the researcher is able to act in multiple capacities and roles. Stake (1995; cited in Cohen et al, 2011) suggested a researcher conducting research in an educational setting must be the teacher, advocate, evaluator, biographer, interpreter, participant observer, interviewer, consultant and theorist.

Adopting each of these roles, the researcher is able to adapt as necessary in various situations and react appropriately; creating new scenarios and designs to study the subject domain (Engeström 1999; cited in Postholm & Madsen, 2006). Conducting a research from a participatory perspective is also considered beneficial in understanding meanings of events and actions and establishing a rapport with participants quickly. Cohen et al (2011) also suggested the researcher’s chosen role and depth of participation at each point will impact the meanings and interpretations developed and inferred during the course of the stud(ies) (Cohen et al, 2011).

Another aspect with some bearing is the previous experience of the researcher (Fink, 2000; Dickson-Swift et al, 2007). Dickson-Swift et al (2007) maintain the art of collecting data in a research process “*can be an intense experience*”, especially if related to human interests and experiences. The authors theorise the researcher’s previous experience may have some bearing in such stressful cases, suggesting this aspect is sometimes ignored (pp. 327). The review of this thesis found this to be true in many instances.

Before working in a UK Higher Educational Institution (HEI), the researcher worked as a tutor for many years in UK further education (FE). Therefore, while the organisational context is based on HE, previous experiences and beliefs held arising from FE teaching experience will also have some bearing on the review processes and findings. Having worked in two of the five main levels of education in the UK (FE and HE), there were easy access to participant colleagues currently working in both of these environments which was of some considerable benefits to the research.

Informal discussions with colleagues in day-to-day discharge of the researcher's contractual responsibilities played a big role in the review's implementation processes and setting the contextual constraints for the review of this thesis. Data from shared experiences of annoyance, disappointments, dissatisfactions and frustrations with the bureaucratic processes was also very useful, not only in framing the research agenda, but in the data gathering and analysis stage of the review of this thesis. These include comments made in staff offices, common rooms and in informal / formal gatherings as well as during interactions with other stakeholders involved: students, educators as well as other colleagues in the role of learning support and governance, content developers and device manufacturers.

Experiences and opinions obtained formally and informally from colleagues in FE, coupled with previously observed practices provided some grounding for comparisons between schools, FE and HE education. The researcher regularly participated in promoting the use and integration of technology in teaching and learning, both from development and delivery perspective. The researcher is also involved in conducting staff development training on the effective usage of new and innovative technologies to enhance the learning process and to create an engaging learning environment.

There are advantages and disadvantages from conducting a research study from an "insider" perspective. Easy access to participants and the research environment was a big advantage, but there is potential tendency to circumvent ethical rules and compromise data integrity by empathising and taking sides in situations, behavioural events or identifying with expressed opinions (Brannick & Coghlan, 2007, pp. 70; cited in Dwyer & Buckle, 2009). Aware of this tendency, the researcher was careful to maintain an objective approach and to minimise intrusions or disruptions in the participant subjects' lives.

Ethical approval was obtained prior to the commencement of the research, guiding every aspect of the process. Participation was also completely voluntary and allowance given to opt out at any point in the data collection process. Consent was sought from every participant. More details on the trustworthiness and ethical policies guiding the research will be provided in subsequent sections

3.4. Fact finding for Requirement Engineering (RE)

The bulk of the fact finding process in RE is usually in the inception and elicitation phase. However, the task will likely continue throughout the life of the project, beyond project specification. For example, whenever changes are made to a system, the requirements for those changes have to be re-evaluated (Berenbach et al, 2009; Easterbrook & Nuseibeh, 2000). Berenbach et al (2009) cautioned not all the information obtained would become requirements because it may not be feasible to implement some needs.

Identification of relevant stakeholders within a system is an important stage. In the review of this thesis, there were several stakeholders with potential input into the system including device manufacturers, learning content developers, educators, students, policy makers and those in the role of learning support and governance. Within each of these groups, there were sub-groups with a cross-section of experiences, also with potentially important perspectives. For example, educators include tutors in HE, some of which may be champions and experts in MDTs' use in learning. Then there were pre-service tutors who may also be relating their experiences and making meanings from being educators themselves as well as from being HE students.

Among the educator group are also educational theorist sub-groups, some of which have little or no experience of using MDTs in the classroom. Similarly, the student body and those in the role of learning support and governance also have sub-groups with potentially differing perspectives. MDTs are often used in contexts where system users may also be service providers. An example is a scenario where a tutor uses the technologies to administer as well as enhance learning in their teaching and learning practice.

So, partly for this reason, identification of relevant stakeholders and getting full participation was always going to be problematic for the review of this thesis. Another aspect playing a major part is the conception of the problem definition. In many of the systems subjected to requirements analysis process or to RE, it is likely some problems have already been identified and the need for redress established among the stakeholders. Clearly that's not the case here, given the review of this thesis began primarily as a perceived need by the researcher and from the researcher's observations and personal experience.

Consequently, buy-in from some of the groups of stakeholders was difficult right from the start of the investigation. There were also difficulties in establishing the root problem. Having input from several stakeholders who are knowledgeable about the domain is however considered very crucial to successful elicitation of requirements in RE. Berenbach et al (2009) suggested stakeholders selected should be able to not only speak for the organisation, but to discuss issues within the domain. The authors also mention the possibility of differences in opinion and finding resolution.

Sutcliffe (2013) agreed, adding there will be a need for trade-offs because it is impossible to satisfy all the requirements by one specification; usually typical of non-functional requirements. When this occurs, analysis of the goals can help to determine those that are essential and those that should be traded off (see Table 7.3). Berenbach et al (2009) suggested discussions about specification of goals, adding trade-offs should not occur during the elicitation process but afterwards when more time may be allowed for more detailed brainstorming session(s).

Some of the data gathered also came from analysis of existing publications, policy documents and secondary data from device manufacturers' websites. There were also data from long-term observations and interactions with many of the stakeholder groups including educators, students and those in the role of learning support and governance. The data was methodically gathered over several years and recorded from a participatory perspective through formal / informal conversations at events, meetings and in the execution of day-to-day work-place responsibilities, from "insider perspective" as outlined in the previous section.

Berenbach et al (2009) believe domain knowledge is crucial to ensure the person tasked with this process is not afraid to ask hard questions when necessary. Berry (1995; cited in Berenbach et al, 2009) refer to this person as the "*smart ignoramus*", who is able to ask: "*What does that mean?*" when necessary. Otherwise, there may be insufficient information or terms used which could mean the same or different things in different contexts (pp. 41).

Another potential problem could arise from the nature of the subject domain under investigation. As a result of the volatility in functionalities and the increasingly convergence nature of MDTs, establishing meaning and interpretations of requirements may be difficult, or worse, impossible if device features keep changing (Jones, 2008; cited in Berenbach et al, 2009). The nature of this volatility is another crucial area for the review of this thesis. Some level of stability may have been assumed in order to determine if it is possible to establish needs.

3.4.1. Modelling the subject domain

Techniques and stages in RE and AOSE are considered to be particularly suited to complex and changing systems; especially when human / agent interactions, roles and relationships are not easily defined. This phenomenon was noted by Yu (2002), highlighting issues related to conflicts between adopters with "*high expectations*" for a system and those "*wary of potential pitfalls*" (pp. 206). The author theorises these conflicts may be exacerbated in complex multi-agent systems where decision-making and problem-solving are likely more intense; making the selection of modelling approaches a torturous task.

Exploring issues relating to the integration of MDT in education is considered a typical example of such systems; presenting unique challenges for the review of this study. Consequently, elicitation and modelling techniques used in RE and AOSE disciplines were employed at different stages of the investigation. Goal modelling was also very useful in specifying requirements for a beneficial / co-evolving relationship between MDTs and education, for identifying functional and non-functional requirements for sustenance of ML practices and for aligning those requirements with the overarching policies and strategies of an institution.

Other methodologies such as Discrete Events Modelling and System Dynamics were discarded because of the focus on problem-solving, seemingly at the expense of agent interactions and decision-making, as well as what Yu (2002) terms "*a greater reliance on codified knowledge*" (pp. 207). The author explained there is a balancing act in proportionate allocations between problem-solving and decision-making within a system.

Unified Modelling Language (UML) was also among those considered, commonly used in object-oriented modelling. However, given its history as a basis for Unified Development Methods (UDM) which was aimed at improving and unifying other object oriented methods such as Object-Oriented Analysis and Design (OOAD), and Object-Oriented Software Engineering (OOSE) etc., Kaschek & Mayr (1998) would suggest UML projects may "*suffer from non-harmonised pragmatics of the incorporated methods*" (pp. 10-11).

In Yu (2002)'s opinion, RE has "*techniques for dealing with*" complex systems more thoroughly; not only exploring the relationships within the systems but also "*clarifying and defining the relationship between intended systems and the world*" (pp. 207). Easterbrook & Nuseibeh (2000) and Berenbach et al (2009) agree, adding modelling techniques of RE may offer ways of simulating and defining the likely behaviour of the system components when changes occur within the system.

Tropos methodology employed in AOSE discipline was also found to be extremely useful; its foundation on Eric Yu's *i** modelling notations, considered simple, easily recognisable and understandable by non-computing experts or non-modellers. Tropos methodology was the preferred option, selected by

Abbas (2010) after an evaluation review involving other AOSE methodologies such as MESSAGE, MaSE, Prometheus and Gaia.

Other fact finding techniques employed in the review of this thesis include evaluation and comparison of existing framework models proposed for ML in Section 2.3.5 and an exploration of current uses of MDTs in learning and teaching, which is also part of systematic review of literature and analysis.

3.5. Data collection methods

An essential part of the RE process employed in the review of this thesis is the importance of obtaining all the relevant requirements. The advantages / disadvantages of combining positivist and interpretivist approaches to research have been outlined in Section 3.3. A mixture of qualitative and quantitative research methodologies was employed in the review of this thesis to gain full understanding of the subject domain. It also minimised errors arising from weaknesses in qualitative or quantitative only approaches (Creswell, 2003; Cameron, Cronholm & Hjalmarsson, 2011).

Fact gathering and knowledge acquisition processes used in RE are usually those borrowed from other disciplines such as interviews, observation, questionnaires, texts and document analysis (Gause & Weinberg, 1989; cited in Sutcliffe, 2013); repertory grids and protocol analysis (Maiden & Rugg, 1994; cited in Sutcliffe, 2013) and an area that is fast becoming common which is ethnographical research employing observations (Goguen & Linde, 1993; Luff et al., 1993; cited in Sutcliffe, 2013). All of these methods have been employed in varying degrees in the review of this thesis to obtain the “facts”.

3.5.1. Data collection plan and design

A phased data collection process was conducted through the life of the review of this thesis. Table 3.1 summarises data gathering timeline for the review of this thesis and an illustrative representation of data collection plan can be seen in Appendix 1. The process is classified into four main phases, conducted both sequentially and in parallel. These are summarised below:

- **Phase I:** State of the art, issues, perspectives and opinions on ML concept and practice was explored through literature review. These provided grounding materials used to design questions for quantitative data collection. Relevant secondary data was also sort through publications, information on websites, blogs, twitter etc.
- **Phase II:** A more extensive study comprising of questionnaire survey / interview of selected groups of stakeholders was conducted.
- **Phase III:** A set of longitudinal study among students from Computing and Non-computing related disciplines as well as pre-service tutors was conducted over one academic year to detect and understand possible changes in preferences and practices. The interview process was also continued, along with sourcing of secondary data.
- **Phase IV:** The shadow observation study was conducted during this phase as well as the remainder of the interviews.

Table 3.1: Data gathering timeline

Data type / description	Method / design	Timeline / duration	Summary
Stakeholder comparison survey	Online / print survey	Jun '11-Jan '13	92 participants: >> 42 academics, 39 students and 11 of those in the roles of learning support & governance
Qualitative interviews of stakeholders	1-2-1 interviews conducted at participant's chosen locations	Mar '13-Apr '14	21 participants from 6 HEIs:; 3 of them pre-1992. (More details on the next slide).
Study among HE students: freshers study	Longitudinal surveys over 1 academic year (across 2 semesters)	Sep '14-Jun '14	No. of participants varied across semesters. 105 students in the 1st semester, 64 in the 2nd.
Study among HE students: pre-service tutors study	Longitudinal surveys over 1 academic year (across 2 semesters)	Sep '14-Jun '14	Comparison study between Computing and non-computing pre-service tutors. No. of participants varied across terms.
Practice observations	In-practice / informal observations of teaching sessions	Jan '14-Jun '14	5 teaching sessions in 5 disciplines observed, participating as one of the students.

There were notes taken throughout the research life cycle of comments and statements made by colleagues formally or informally to the researcher. Some of these were considered relevant and part of the fundamental perspective of the review of this thesis.

3.5.2. Quantitative research methods

Descriptive approach was used in the quantitative design for the review of this thesis. The aim was to obtain enough data and identify relationship variables that can be further explored (Jones & Bartlett, n.d.; Akram et al, 2007). Questions were originally designed from a review of literature and systematic analysis, and then piloted among a subset of each stakeholder group. The same sets of questions were posed to educators, students and those in the role of learning support and governance, to determine correlation and difference in perception of beliefs and issues. See Appendix 5 for a list of questions asked. The survey was administered online and in print.

An advantage of using descriptive approach include the ability to collate enough data for further correlation study even when the sample lacks enough depth for generalisation, as was the case in the comparative study (Jones & Bartlett, n.d.; Akram et al, 2007). Subsequently, questions were modified to reflect findings from data collection in previous phases. In this manner, qualitative data was collected within several progressive phases of the research.

Holden (2004) suggested generalisation within a research domain require a sample size; enough to present explanations and understandings about anomalies and irregularities and allow predictions to be made about future behaviour. While the sample was not large enough to be representative, therefore allowing for the opportunity to generalise, it was possible to obtain useful data that also provided input into the qualitative process.

3.5.3. Qualitative research methods

Following on from the data obtained during quantitative study, a selection of the stakeholders within the domain, including students, educators and those in the role of learning support and governance were chosen for further qualitative study. Jones & Bartlett (n.d.) called this purposive sampling; defining the term as the conscious inclusion (and exclusion), as well as the contextual grouping of certain groups of participants.

With the purpose of this being to examine the relationship between MDTs and education, and given other mitigating factors such as access and willingness of the selected subjects to participate in the review, this approach was considered the best option. The data provided means of obtaining ethnographical information on the stakeholders as relating to the research subject although it was impossible to generalise about the domain. Methods employed include group and individual interviews, participant observations and shadow study.

3.5.4. Sources of data

Given the premise suggested by Dickson-Swift et al (2007) that the researcher's previous experience will have some bearing on the research, it may be concluded data collection period began well before the registration of the review of this thesis. Formal process of data collection began in September 2009 and ended in June 2014. Choice of sources and methods were partially influenced by the findings from systematic analysis of literature, and partly from expediency; finding creativity was necessary at times to maintain data integrity.

Selection of stakeholders

Students and educators are important data sources for the review of this thesis. Calls for learning transformation and moving away from traditional teaching methods have always been justified from the viewpoint of making the learning more interesting, engaging and motivating for students as well as improving their experience during their programme of study. Information about perceptions, mis-match of requirements and meanings within the domain among the two groups of stakeholders as well as requirements and needs were necessary data for the review of this thesis.

A sub-group among the students and educators groups are the pre-service tutors who are both students (in HEI) and educators themselves. Information was gathered about their experience and about their practice as relating to the subject domain. The last sets of stakeholders involved in the review of this thesis are colleagues and those in the role of learning support and governance. Colleagues provided valuable insights about their perception on the performance of the organisation(s) involved in the review of this thesis.

Those in the role of learning support and governance include those supporting learning and those involved in making strategic, operational and policy decisions in HEIs. Some content developers and personnel in device manufacturer sector were also consulted. Casual (informal) observation by the researcher was also an important aspect of the data collection process. Data was obtained by the researcher from internal communications (both oral and written), informal comments, actions etc. Other sources of data include documents and records obtained from websites and printed matters by the organisation(s) involved and by mobile device manufacturers.

Primary data sources

Primary data sources include quantitative surveys, qualitative observations, interviews and focus group studies. The particulars of the design for these studies are provided in details next, while results are presented in Chapters 6, 7 and 8.

Quantitative surveys

Two different quantitative studies were conducted during the course of the review of this thesis. An initial comparison survey was conducted at the start of the research. There were a total of 92 participants, including 42 academics, 39 students and 11 of those in the roles of learning support & governance. Most are closed question types requiring “Yes”, “No” or “Don’t know” or other specific responses. Same versions of the questions were posed to each of the participating groups as relevant in other to compare responses. A few of the questions, such as comments and explanations for some of the selective responses were open, making it possible to obtain qualitative responses that could be explored further in subsequent phases.

The second quantitative study was conducted in the third phase of the research, along with a set of longitudinal study over one academic year among students from Computing and Non-computing related disciplines. A total of 215 students participated in this particular study. Of this total, students newly enrolled in the university i.e. in their first year of study were selected, 105 in semester A and 64 in semester B. The students were given the same set of questions at the beginning of each semester, in October 2013 and February 2014.

The object was to determine if there were variations in perspectives and opinions, perhaps reflecting impacts of environmental conditions on the students' growth and progress during their university education. Consequently, some of the question wordings were changed to reflect the timing. For example, "*Do you expect to be allowed to use smartphone(s), mobile phone(s) or tablet PC for your learning?*" at the beginning of the first semester was replaced with "*Are you allowed to use mobile/smartphones / tablet PC (e.g. iPad) during your learning?*" and so on, to compare expectation with reality.

<u>Qualitative interviews</u>

Academic stakeholders and those in the role of learning support and governance in HE were invited to participate in interviews. In addition, there were also a number of informal interviews conducted with colleagues, academic lecturers and students during observations. In total, there were 21 formal interviews comprising of academics who are ML enthusiasts and educational theorists, university board members, content provider, IT support personnel and learning technologists.

Interview questions were open-ended, inviting perspectives and opinion for later analysis. Subsequently, participants were followed up on certain aspects of their responses via emails or telephone interviews. All the interviews were recorded; participants' consent obtained for both the interviews and the recording of interviews. As several are known colleagues, the interview was conversational and sometimes informal while ensuring issues that are unclear are followed up in subsequent questioning. All the interviews were conducted between 2013 and early 2014.

<u>Focus group interviews</u>

Focus group study was conducted among a group of students on secondary PGCE programme pre-service tutors. Students were selected from Non-computing (Modern Languages) and Computing tracks to determine if there are similarities / differences between them with regards to issues within the domain. The focus group was conducted in longitudinal study mode over one academic year which the review of this thesis found to be “flexible”, evolving “*contextually in response to the lived realities encountered*” (LeCompte & Schensul, 1999; cited in Creswell 2003, pp. 14). Each group attended at least two focus groups, held at the beginning of their study, and at the end of Semesters A and B.

Participation depended on students in attendance on the day. Therefore, although the whole group agreed to participate, there were only 8 students in attendance for the Modern Languages track in Semester A and 10 in Semester B. A total of 10 students on the Computing track were in attendance for both studies. However, 2 of the pre-service tutor students were not in attendance in one of the studies, either participating in Semester A or B study only. These students admitted they were aware of the other study, responses may therefore have been impacted by this awareness.

Classroom observations

It has been theorised perceptions and opinions expressed in formal responses often may not reflect actual practice. This have been attributed to likely difficulties in recalling actual events, the tendency to present anecdotal accounts to appear more interesting than they actually are in reality or reluctance to admit to the truth, especially if it could show the subject in a negative light (Lincoln & Guba, 1985; Creswell 2003). Observational study of actual events can be used to overcome these and other drawbacks applicable to other research methods (Creswell 2003).

A session each was selected at random and for accessibility on 5 different modules, one each from Psychology, Arts and Digital Industries, Computing and Engineering, Education and the Social Sciences disciplines. Sessions were observed in “mystery shopper” mode, posing as one of the students and making notes on behaviour during the session in order to ensure observed behaviour was normal occurrence. Afterwards, informal interviews were conducted of some of the participating students and in one instance, the academic tutor.

Participants were informed and consent sort only in instances where it was necessary to follow up the proceedings during the session with interviews. In all instances, care was taken to ensure identifying information was not included in the accounts. Record of observations were primarily notes of the accounts. In one instance, the academic tutor was asked for access to the module guide and assessment specification for the module to provide further clarity on certain events occurring during the session. The academic tutor interviewed informally at the end of one session also consented to participate in a scheduled interview afterwards.

Practice observations

Observational notes were also taken right through the lifetime of the review of this thesis. Some of these were made during departmental meetings, events and conferences attended in both the participating institution and other HEIs in the UK. Statements made to the researcher by stakeholders in HEIs were also included in anecdotal evidences recounted in this thesis. For example, the research's career in HEI started as a member of the learning support personnel. Subsequently, the researcher was transferred to IT Services, with colleagues in learning and systems support as well as learning content provision. Information obtained as a result of these associations were incredibly crucial to the outcome of the review of this thesis, providing opportunities to make relevant observational notes on practices relevant to the review as they occur.

There were also observational notes made on student behaviours and practices through participation as a student. During the course of the review of this thesis, the researcher undertook three postgraduate modules each lasting for one semester and providing access to view student behaviour from another perspective among three different cohort of students. Assumed ages on these course modules range from mid-20s to mid-50s, with only a member of one cohort aged 64. The results of these observations are reflected throughout this thesis while others are reflected in outlines presented in Chapters 6, 7 and 8.

Secondary data sources

Secondary data sources provided quantitative and qualitative raw data as well as results from analysed research studies that are considered relevant to the domain of studies. Some data were extracted from reports and thematically analysed and / or interpreted as relevant, presented throughout the review of this thesis and in Chapters 6, 7 and 8.

Market surveys of mobile device usage among consumers

Some secondary market surveys and BYOD survey data from UK HEIs were available to the review of this thesis, obtained from the universities' websites. The market surveys are primarily on consumer behaviour in general as related to mobile devices. BYOD surveys were found to be relevant as these concern UK HE students. These include the following:

1. Oracle online survey (2011) of 3,000 mobile phone users, 18 years and older from North America, Europe, Asia Pacific, Latin America, and the Middle East.
2. UCISA HEITS (Higher Education Information Technology Statistics) survey of IT governance in 62 UK HEIs (2010 & 2011).
3. Ofcom (UK's communications regulator) omnibus survey 2013's report on device ownership of smartphone, tablet and netbook / laptop users.
4. BYOD / device ownership studies among students in UK HEIs:
   a. *Northampton University (Dec 2013 / Jan 2014)*
   b. *London School of Economics (2013)*
   c. *Manchester University (2013)*
   d. *Sheffield University (2011)*
5. BYOD / tablet use in schools and FE conducted by British Educational Suppliers Association (BESA).

The findings of some of the BYOD studies have been presented in Section 1.3.2. Market survey data was also considered relevant to determine trends among consumers of which stakeholders in UK HEIs are part.

Student demographic surveys

Student demographical data was obtained from the HEI in which the investigation was conducted as well as statistical data from HESA (Higher Education Statistics Agency)[6] website, available to the general public. Statistical data obtained include first releases for 2012/13 as well as official data

[6] https://www.hesa.ac.uk/stats

for 2011/12 and 2010/11. Some more specific data were also requested from HESA to provide more depth and triangulation. Some of these findings are presented in Chapters 5, 6 and 7 of this thesis.

3.6. Data analysis and interpretation

One of the beneficial advantages to the review of this thesis is the access available to the researcher to observe the practices and behaviour of colleagues from within the research domain as an insider. Consequently, the findings from data analysis and interpretation presented in the review of this thesis will be affected by contextual perspectives gained as an insider observant as well as participant.

3.6.1. Quantitative survey

Surveys and all quantitative data collected were collated and analysed using Microsoft Excel spreadsheet application. Since descriptive approach was used for data collection, frequencies, means and percentages were the analysis metrics applied; making it possible to compare meanings and findings from two or more groups of stakeholders (Jones & Bartlett, n.d.; Akram et al, 2007).

3.6.2. Qualitative interviews and audio recordings

All audio recordings of interviews were transcribed into texts. The transcription process provided an opportunity for simultaneous preliminary analysis which helped in the coding process. Once the transcription process was completed, codes were derived and used to analyse the data using ATLAS.ti, a CAQDAS. This made it easier to apply the same coding metrics, analyse and collate themes and meanings as well as to manage the analysis process at the same time.

3.6.3. Shadow observation and field notes

Since the object of shadow observation is not only to record comments but to observe behaviour and actions, there was no need to transcribe audio recordings of the sessions as these include irrelevant and some identifying information. Recordings were listened to immediately after to double-check notes taken during the session.

3.7. Research ethics and trustworthiness

Mack (2010) maintains all research is subjective and the very act of selecting a method over another is an expression of subjective preference of one method over another. Krefting (1991) agreed, adding: "*The worth of any research endeavour, regardless of the approach taken is evaluated by peers, grant reviewers and readers*" (pp. 214). Consequently, worth of the product from a positivist approach may be easier to recognise and document than in a research conducted using the interpretivist approach (Seale & Silverman, 1997; Krefting, 1991).

3.7.1. Trustworthiness

Trustworthiness is sometimes express in terms of research rigour, applicable throughout the research process. Rigour is in turn expressed in terms of validity and reliability (Rolfe, 2006). Other writers express rigour in terms of

- ***credibility (or internal validity)****, defined in terms of how "true" the findings are,*
- ***transferability (or external validity / generalisation)*** *should indicate whether the findings can be applied to other contexts,*
- ***dependability (or reliability)*** *reflects the findings' consistency and repeatability,*
- ***confirmability (or objectivity)*** *indicates the extent to which the findings are void of the researcher's prejudice, preconceptions, interests or motivation i.e. consisting only of participants experiences and perceptions of the research subject.*

Lincoln & Guba, 1985; cited in Shenton (2004).

Quantitative studies aim to achieve validity by conducting the research among a random sample of the population. Other scientific or statistical methods add additional ways of ensuring validity and reliability. This is impossible in a qualitative process. The subjectivity of the observation process is cited also as a likely source for reliability error in a qualitative process. Different researchers are likely to come up with different records when observing the same events and situations. Also, while findings in quantitative studies are obtained from questionnaires with set answer choices, questions in qualitative interviews are of necessity open-ended. This leads to criticism about the reliability of the schedule and sample size (Seale & Silverman, 1997).

Rolfe (2006) however suggests "validity and reliability are achieved when the researcher rigorously follows a number of verification strategies in the course of the research process" (Morse et al, 2002; cited in Rolfe, 2006, pp. 305). Therefore, following established research procedure and techniques, it is possible to maintain reliability and validity in the research process. Seale & Silverman (1997) agrees, stating while qualitative research methods are plagued by "issues of reliability and validity" and more so than quantitative methods, there are ways of maintaining rigour in a qualitative research process (pp. 379).

The authors add that authenticity rather than reliability is the goal in qualitative process. Qualitative research ensures authenticity in the process by providing data that reflects experiences, meanings and interpretations, using open-ended questions. Audio recordings used in qualitative research processes also add another way of ensuring rigour and reliability by providing a way to re-analyse the data if and when new hypotheses are arrived at. Transcription of the recordings offers a way to record naturally occurring phenomenon. This technique will be impractical in a quantitative process.

Others believe there is inherent reliability in the ability of qualitative data to present a real life image of the world around us. Seale & Silverman (1997) disagrees this is a reliable way of maintaining rigour and validity, adding knowledge and feelings are not "*of equal weight and value*" (pp. 380). The authors also suggest perceptions and interpretation of events may arise from flights of fancy rather than fact in a qualitative process. Seale & Silverman (1997, pp. 380) suggest the following strategies instead:

- Using counts of events to support generalisation.
- Use of a combination of qualitative and quantitative methods to ensure representation of cases.
- Performing multiple hypotheses testing to allow for analysis of deviant or contradicting cases.

- Use of qualitative analysis computer applications or Computer Assisted / Aided Qualitative Data Analysis Software (CAQDAS) such as ATLAS.ti (used in the review of this thesis), NVivo, QDA Miner or MAXQDA.
- Ensuring data is objectively and comprehensively recorded and supported by audio and video recordings as well as transcripts.

Mack (2010) believes interpretivist research methods are more likely to resonate with educators, reflective of their own work and practice. It allows avenues for the achievement of change and improvement in established practices. The qualitative researcher in an interpretivist paradigm may overcome many of the disadvantages by ensuring the data only "*informs the researcher about what is going on in the environment*" and it is not in any way about "*the researcher's own preconceptions*". The researcher must seek only to "*understand rather than explain*" (Mack 2010. pp. 8).

These strategies, guidelines and techniques were employed in the review of this thesis to ensure rigour. For example, a mixed method of inquiry approach was chosen in order to obtain extensive data on factors / issues. Stakeholders were also selected from as many relevant groups as possible, also as a means of adding rigour and robustness to the research studies within the domain.

3.7.2. Ethics

Research ethics go hand-in-hand with the reliability and dependability of the research. It specifically concerns the researcher's responsibilities to the research subjects and participants. Ethics is also about maintaining a moral high-ground; ensuring there are no fabrications, falsifications, misrepresentations or misinterpretations i.e. holding onto the absolute truth at all times. Falsification of data may not result in dire consequences in the review of this thesis as may be applicable to those involved in clinical trials. It is however unethical to engage in falsification and must be avoided at all costs (Resnik, 2011).

At the start of the review of this thesis, an application was made to the University Research Ethics Committee (UREC) of the University of East London (UEL) for ethics approval which was granted (Appendix 9). The assurances given in the application was rigidly adhered to during the review of this thesis. Consent was sought from participants and information anonymised. No participant's name have been associated with the information given or findings without obtaining express permission first. Participants were also duly respected at all times and their safety prioritised. The data collection process posed no known risks to the health of the participants.

All data including audio recordings, transcripts, surveys, consent forms, observation notes etc. were stored securely and confidentially. Data held electronically were stored on computers requiring login authorisation for access. As soon as all the written work for the research is completed, all data collected for the research will be destroyed securely and permanently. The data will not be held for longer than is statutorily permitted by the researcher.

Online surveys

An online survey was designed and created to obtain information from the stakeholders: educators, students and those in the role of learning support and governance (Appendix 5). A brief explanation was provided on the first page of the survey with the researcher's contact information should there be any questions. Submissions were anonymous.

Some of the participants were groups of student cohorts who completed the survey at the start of their classroom sessions and educators during meetings. A brief verbal explanation (Appendix 5) was always provided at these times and participants reminded to ensure there are no identifying information supplied on the survey forms which were collected and stored securely before the data was recorded electronically.

Freshers' survey / interview

Part of the data collected for the review of this thesis included a longitudinal study conducted among new students during their first year of starting at university. During their first week on campus, all interested students were invited to participate in this part of the study as part of the enrolment activities.

After a brief explanation and interview, the students were asked if they wanted to participate further, and if they do, they were invited to complete a consent form and provide contact details voluntarily.

Because majority of the students who signed up to participate further were from Non-computing disciplines, the same survey was also conducted among a cohort of students on BSc Computing and Software Engineering programme. They were also given a brief explanation and allowed to opt out of further study if they so wish. Those agreeing to further study were invited to provide contact details. Personal details provided by both group of stakeholders was used only to contact them for subsequent studies. Care was taken to ensure the data collected was not linked in any way to the students' contact information during collection, analysis and in findings presentation.

Pre-service tutor focus group

A second longitudinal study (over the course of one academic year) was also conducted among two cohort groups of computing and multi-language pre-service tutors. This consisted of group interviews in focus group sessions. Again, an explanation was given to the students at the start about the rationale for the study and the review of this thesis and the students were asked if a recording of the process could be carried out. Students were also invited to participate further voluntarily. Three focus study sessions were held with the computing pre-service tutors' cohort and two with multi-language pre-service tutors during the review of this thesis.

Although the students were warned not to mention each other by name or mention their names or any identifying detail during the sessions, there were occasional lapses which meant anonymity was not maintained and cannot be guaranteed. Therefore, the students were given the option to opt out if they object to their names being recorded in error and perhaps linked to the information provided. Students were assured names will not be linked to the information given in findings presentations and publications unless express permission was given.

Qualitative interviews

Qualitative interviews lasting between 50-75 minutes was conducted among educators and those in the role of learning support and governance. Course coordinators of pre-service tutors were also interviewed for the review of this thesis. Majority of the interviews were conducted face-to-face, a few by Skype. Participants were given the option to choose an interview location as convenient and consent sought for audio recordings of the interviews. Participants were also asked to sign a consent form provided; those interviewed on Skype had an electronic copy of the consent form which was signed, scanned and emailed back.

As for all the data collection efforts for the review of this thesis, participants were warned at the start of each interview that while specific identifying information will not be recorded or linked with the information given, identification may be possible through information provided or lapses when names / identifying details are mentioned during recording process. As for the focus group / interviews, they were warned anonymity may not be possible in such instances and given the option to opt out.

Classroom observations / shadowing

A number of classroom observations were conducted sometimes with the consent of academic tutors in charge. The object was to determine how students use MDTs to enhance their learning. Because of the nature of the review of this thesis which was to gain an understanding of practice on the ground, it was determined that informing the subjects prior to some of the observations may impact responses and behaviours. Therefore, some classroom observation were conducted in ‘mystery shopping’ mode with the research playing the role of another student in many cases.

It was understood that some participants may be uncomfortable with this type of shadow study and may feel their practice is being scrutinised. Therefore, participating (tutors and students) were given the option to opt out of the review of this thesis once data collection was completed and informed fully of the proceedings. The information provided by those who opt out was excluded from the analysis, findings presentation and any publications. The researcher also took the responsibility to ensure the data is collected and handled as anonymously as possible.

Observations, notes and data collected informally

As was mentioned in previous sections, the review of this thesis was conducted from insider perspective. Therefore, some comments and statements made to the researcher at various times during the review of this thesis formed part of the discourse in this thesis in some way. While many of the colleagues recorded this way were aware of the status of the researcher, because of the nature of this type of data collection, it was sometimes impossible to obtain consent in every instance.

Therefore, the researcher again took responsibility for ensuring information recorded was ethically handled, and there was no way comments and statements can be linked directly to anyone. Where substantial information was collected that could be linked to a colleague, their consent and permission was always obtained before the data is included in the review of this thesis.

3.8. Synopsis on research methodology

In this chapter, the research design, operating parameters, methods and terms of reference have been outlined along with considerations for trustworthiness, rigour and ethics. Also in this chapter are discussions on the philosophical view point underpinning the review of this thesis along with assumptions, stakeholder selection for requirement elicitation and some of the rationale for proposing modelling techniques of RE for gaining more clarity on the factors and issues within the subject domain.

In just over a decade, MDT has transformed the society so much keeping up with its development and impacts on world systems, established practices and individual lives has become a way of life. The review of this thesis is primarily concerned with understanding what impact, if any, MDT may be having on the educational sector. The methods and strategies explored in this chapter are designed to help achieve that purpose.

In the next two chapters, a series of concepts and fundamental precepts with bearings on this research are first discussed before the findings are presented in Chapters 6 & 7. Co-evolutionary concepts as an option for the future of practices in ML will also be discussed briefly, along with recommendations from the review of this thesis in Chapter 8.

Chapter 4

The formulation of the problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill.

~ Albert Einstein

Establishing requirements for ML and MDTs in education

4.1. The contexts, complexities and propositions

As discussed in Chapters 1 and 2, the lightning pace of advances in Mobile Device Technology (MDT) presents untold promise on the one hand and challenges on the other for education. Technological advances often break established moulds with new innovations, but that makes appropriating them successfully into education difficult; innovations of today becoming obsolete almost as soon as appropriated. This phenomenon leaves learning and teaching in a perpetual chasing mode, behind the very innovations that could potentially transform these sessions.

Regardless, appropriation of MDT into education may be just as unstoppable as it has been in the society (Kukulska-Hulme, 2010). Business organisations and publicity / media systems now take advantage of MDTs in ground-breaking ways unthinkable a few years ago. The media for example relies on MDTs to access and report the latest news and occurrences around the world and entire business models are built on the assumed availability of devices and wireless technologies within the society e.g. advertisement and publicity strategies.

MDT is also creating new career options and trends. For example, many application developers make their living by providing innovative purpose-built apps targeted at MDT systems. Curriculums and course programmes in all levels of the UK educational systems are also being adapted to accommodate these changes. It is therefore not unlikely for universities to offer both UG and PG course programmes which include MDT streams. Examples of such programmes include Mobile Software Engineering offered by University of Glasgow, Mobile Telecommunications offered by Anglia Ruskin & Loughborough Universities, Wireless Communications offered by University of Southampton and so on. Schools and FE offer various certificated course programmes on mobile app (applications) development as well as wireless communications.

Ownership among students have almost reached saturation and still growing (see Section 1.3.2), MDT's presence on campuses and within the hallowed halls of learning becoming more and more entrenched and expected. In contrast, appropriation / integration into learning and teaching is in decline (see Figure 1.1). In this chapter, it is suggested application of domain neutral Requirement Engineering (RE) techniques may provide insight into the likely reasons for this and a way of establishing needs and requirements for Mobile Learning (ML) in a bottom-up approach, developing a theme started in Chapter 1. It is also proposed RE techniques may offer strategies for modelling and aligning institutional goals with those needs and requirements. This chapter establishes a background for the ML system models presented in Chapter 7.

4.2. Requirement engineering "ML" into "mobility in learning"

Asked what ML is and ML proponents would invariably mention mobility of the learning process, the learning, the technology or all of those. They may go on to talk about pedagogy and the fact that MDT should serve or enhance the learning objectives and not the other way round, as may seem the case in some implementations. They could add attributes, such as the ability to learn anywhere and at any time, wherever the learner may be, and may suggest the availability of *the learning* at the learner's convenience or pace may be key differentiating factors.

For all of these descriptions however, there are often counter-arguments, suggesting there is fuzziness within the concept that hasn't gone unnoticed by skeptics and researchers alike (Ferdig and Boyer, Traxler, 2007; Dyson et al, Frohberg et al, Peng et al, Yi et al, 2009; Kukulska-Hulme, 2010; Cruz et al; Traxler, 2012). A key question for this research therefore is if RE could provide a useful way forward for ML in learning and teaching.

In Section 1.4.1, a preliminary discourse on RE suggests some justification for its use for ML which include the complexities in ML systems and usage contexts. Consequently, establishing requirements for ML can be complex, as was discovered on the MOBIlearn project which spans several countries and institutions. The project used the Volere shell template proposed by Robertson & Robertson (2003; cited in Sharp et al, n.d.) to elicit requirements from stakeholders. To simplify the complex process involved, the project categorised research strands through learning contexts such as informal learning in museums, work place training in health-related studies such as with first aiders and students on an MBA programme. Requirements were elicited from student and educator stakeholders within these strands and this was used to design implementations to evaluate the findings.

This attempt on the MOBIlearn project is more or less typical of requirements establishment for ML. While the methods used are similar to those proposed in the review of this thesis, in that a bottom-up approach of establishing requirement first before implementation was employed, the discipline-based focus may present problems in bridging the gap between research and practice. Devinder & Zaitun (2006; cited in Sarrab et al, 2012) found there haven't been many research done to establish students' requirement needs for ML and for the use of MDT in learning in general (pp. 33).

According to Easterbrook (2004), there is no one prescriptive way of applying RE techniques to a system, its application depending on the goal of the system and the contexts within which it is being used. Therefore, while there may be a variety of ways of applying RE techniques in a system, the following stages are considered essential, especially for the review of this thesis:

- **Elicitation of needs:** Involving the liaisons and interactions with relevant stakeholders and experts within the system to understanding the system and establish needs, using a mixture of quantitative and qualitative research methods.
- **Identification, analysis and negotiation:** What are the current and new requirements, who are those involved and where are they located? Conflicting requirements or potential problems must also be identified, negotiated and resolution decided.
- **System modelling and goal specification:** Various modelling techniques may be employed at various stages of an RE process including artefact, feature, process or goal modelling etc.
- **System validation, risk and change management:** System model(s) and specification are evaluated against the requirements and agreed or further negotiated until an agreement is reached. Strategies for managing risks and changes to the system will also be determined.

These stages are part of the grounding framework for the review of this thesis and will be discussed next.

Elicitation of needs

Elicitation of needs and requirements can be the most complex part of an RE process. Elicitation must ideally be conducted among all the stakeholders with influences within the system. Several of these may have conflicting needs and requirements while some may be unsure of what those are. In addition, it may be impossible to correctly determine stakeholders in some ML systems prior to implementation. The ever shifting nature surrounding MDT itself presents another problem. Features and educational affordance of MDT changes constantly; as do the sophistication and complication of systems, platforms and networks surrounding MDT.

Stakeholders with potential input into the ML system include device manufacturers, learning content developers, educators, students, policy makers and those in the role of learning support and governance. While device manufactures may not be particularly interested in prioritising the needs of the educational community, especially if that's not the most profitable option, they are likely to be concerned if devices are unusable by members within the community. If the device is overly complicated then consumers, who may also be students and / or educators will not want them. Device manufactures may also be concerned about policies preventing freedom of usage in learning establishments.

Educators are often keen to appropriate technology that would make their practice more effective and achieve learning objectives. They may however allocate inadequate amount of time to gaining skills necessary for effective pedagogic and instructional design (Beer, n.d.). In the same way, students may own devices but unable to use them effectively for learning (Clough et al, Duncan-Howell & Lee, Dunleavy et al, Litchfield et al, 2007; Dyson et al, Peng et al, 2009). Seamless usage may also be problematic because the necessary connections and support are not adequate or robust enough, or there may be policies prohibiting use (GSMA, 2011; BESA, 2013).

For learning providers, as may be true also for educators and students, running cost is still an issue. Costs may also include provision of ongoing technical support by the institution. Interoperability with other applications on the local network systems will be essential and ensuring the environment is rich enough to support such levels of inter-connectivity as may result could be beyond sustainable budgeting strategies. And while mobile devices include tablets / devices with wide screens, powerful media support features and educational affordances, there are many with less than satisfactory experience still. It is believed this will increasingly become less of an issue (GSMA, 2011).

Learning content developers may be educators or independent developers of learning applications and systems. Many ML systems attempt establishment of requirements through content specification (Olasoji & Draganova; 2010; Wilson & Woodill, 2011). As well as being a logical approach when it is not possible to determine the demographics of system stakeholders in a precise manner, it is often a prudent approach which recognises appropriate content provision is a key part of an ML system. The problem with this approach is provision of content does not guarantee they can be used to facilitate “deep learning” (Liu et al, 2007; cited in Brown, 2010; Wang et al, 2009; Kukulska-Hulme, 2010; Valcke, 2011). Where stakeholders are unknown, they will need to be estimated, with target audience and their needs within the system consulted.

Personal preference and cultural perceptions will also play a key role in intentions to use. For instance, in the past majority of consumers are uncomfortable conducting financial transactions on mobile devices. Today, the number is growing despite persisting security concerns (Oracle, 2011; We Are Apps, 2013). Possibilities of cyber bullying and abuse are other issues among others; often given as reasons for imposing bans in schools (Barkham & Moss, 2012). Participants in a preliminary research conducted for the review of this thesis stated of mobile devices: “*can cause epilepsy – when it does not work*”, “*too dangerous*” and “*very dis-humanising*”.

These statements may represent some of the extreme opinions held by some stakeholders still. Thus, these and other concerns must be elicited and addressed. It is also important to identify sub-groups within each stakeholder groups with potentially differing opinions. For example, the educators' group may include tutors or pre-service tutors who may also be students themselves in HE (Higher Education). Jones & Bartlett (n.d.) called this purposive sampling as described in Section 3.5.3.

Techniques used in elicitation may typically be employed in other RE stages including those for eliciting and analysing goals for the system, which Ang et al (2011) suggest is sometimes overlooked but an important part of fact finding. Establishing goals may in fact aid requirement analysis and can be analysed using goal modelling (Berenbach et al, 2009). One of the more commonly known goal modelling techniques is KAOS (also known as "Keep All Objectives Satisfied" or "Knowledge Acquisition in Automated Specification"), suggesting the use of verbs as well as 'AND' / 'OR' operators to link goals to processes (Lamsweerde, 2001). Goal modelling will be discussed and illustrated in more details in subsequent sections.

Other elicitation techniques include ethnographical research methods (Ang et al, 2011; Easterbrook, 2000; 2004). Ethnography is an exploration of the community concerned and the cultural contexts using quantitative methods such as surveys, and qualitative methods such as observations, interviews and focus group studies. In this manner, interests and the emotional appeal of components within the system or the product being developed can be measured (Berenbach et al, 2009). Brainstorming and prototyping may also be employed during the elicitation stage.

Identification, analysis and negotiation

This is a logical stage following directly or conducted in parallel with the elicitation of requirements. Information obtained from stakeholders need to be analysed, categorised and ranked. What are the current and new requirements? Who are those involved and where are they located? What are priorities for the business or organisation, and what are the conflicts? Conflicting requirements or potential problems must be identified and resolution decided.

Stakeholder agreement on the goals and requirements could be difficult to obtain without negotiation. Alternative options and acceptable compromises must be presented to resolve complex dissensions and disagreements on requirements and / or goals. Identifying and phrasing the most important goals for the system in terms all stakeholders can agree with and understand may also be useful (Easterbrook, 2000; Berenbach et al, 2009).

Establishing agreement on root problems can be problematic as in the ML system. Many of the stakeholders may be steeped in blame culture, making buy-in from stakeholders difficult. Even when buy-in is assured, having input from several groups of stakeholders may present a problem for the elicitation process (Berenbach et al, 2009; Sutcliffe, 2013). Sutcliffe (2013) suggest the use of trade-offs when satisfying all requirements by one specification prove difficult as may be the case with non-functional requirements. Examples of the use of trade-off analysis techniques for the ML systems can be seen in Table 7.3 and Appendix 12.

Berenbach et al (2009) propose negotiations and brainstorming in several scheduled Quality Attribute Workshops (QAWs). In QAWs, the facilitator creates a Quality Attribute Scenario (QAS) for each of the concerns expressed by a stakeholder. Each stakeholder can express two or more of their most important concerns. The QAS is presented to the group and a handful is selected and debated. Finally, the facilitator supports the group to identify important requirements to be included in the system.

Another potential problem could arise from volatility and frequent changes surrounding MDTs, requiring an acceptable stable framework is established among stakeholders (Jones, 2008; cited in Berenbach et al, 2009). Other techniques employed may include prototyping, global analysis, focus group, requirement analysis and release planning (Berenbach et al, 2009).

System modelling and goal specification

Modelling is an essential RE technique often used to analyse requirements as well as goals at various stages throughout the process lifecycle. Some of the more commonly used modelling techniques are listed below:

- **Artefact modelling:** Used to define the work products and interdependencies and to specify maintenance requirements for processes.
- **Goal-oriented modelling:** Concerning the needs and vision of the business organisation and not necessarily the customers or users of the service(s) or system products.
- **Model-Driven RE (MDRE):** Model-driven RE is typically used for large complex systems and can span the project lifecycle, from inception through to maintenance.

Berenbach et al (2009)

Other modelling techniques used in RE include feature and process modelling, typically used during the elicitation phase.

System validation, risk and change management

During this stage system model(s) and specification(s) are evaluated against requirements and agreed. Validation process can often be another complicated part of RE, resulting in inability to reach a consensus agreement, especially where different stakeholders with conflicting opinions and goals are involved. Risks to the system are identified and measures established to minimise their effect on future optimum performance of the system and to manage changes.

Easterbrook & Nuseibeh (2000) warns, “If stakeholders do not agree with the choice of problem frame, it is unlikely that they will ever agree with any statement of the requirements”. Karlsson & Ryan (1997; cited in Easterbrook & Nuseibeh, 2000) agree, the authors suggesting a resolution may be to promote an agreement “without necessarily making the goals explicit”. In other words, rephrasing goals and requirements using terms that may be more moderate than specific (pp. 6).

Several RE methods have been suggested for investigating ML and similar systems, and for aligning the goals of the system with learning / business strategies. In the next two sections, modelling techniques are explored in more details and a case study using goal modelling to specify system and organisational goals will be presented. Information used in the goal model will be extracted from corporate and operational strategies of a UK HEI, demonstrating how alignment may be more easily achieved.

4.2.1. Goals modelling and requirement classification

Investigating a system is a key initial step for RE but not the end of the process. Once knowledge about the system has been adequately explored, information obtained needs some classification and analysis. Stakeholders' implicit or explicit requirements will need to be organised, ranked and / or categorised in order to identify them as either goals or requirements (or both) of the system. This can often be complicated by the many different classification techniques available in RE. Again, the technique chosen will depend on the objectives for the system and the type of information to be analysed.

Some authors suggest goal analysis and specification is one of the methods that should be prioritised more (Berenbach et al, 2009; Lamsweerde, 2001). These authors believe that while many appreciate its importance, it is often side-lined in literature and formal specifications. Goals are well understood to be objectives or targets to be satisfied by the system under development, and they may often be explicitly presented to system engineers by stakeholders at project inception. The assumption then, that a formal specification for achieving those goals is all that's required may account for the oversight. Lamsweerde (2001) refer to this as the "top-down" approach (pp. 3).

For Berenbach et al (2009) and Lamsweerde (2001), the initial set of goals is just the beginning of goal development process; an important basis on which to continue further analysis and refinement. Lamsweerde (2001) believe further considerations will require asking the 'HOW' and 'WHY' questions (pp. 3). Thus, goal elicitation continues alongside establishment and elicitation of needs. Conflicts and problems are identified and resolved. New features or changes in the system will require alterations or modifications. New goals may also arise from validation, risk and change management processes (Lamsweerde, 2001; Berenbach et al, 2009).

Goal modelling is sometimes seen as a discipline of sorts and also known as Goal-Oriented Requirement Engineering (GORE). This section outlines some strategies used in GORE, which may be employed throughout a project lifecycle during the RE stages discussed in previous sections. However, it is perhaps important to be reminded of the ultimate end-goal at this point, which is to gain thorough understand of ML systems and the environment within which it operates.

Therefore, while goal modelling and classification techniques may be enough to offer some clarity and a way of specifying requirements for ML, there are other requirement classification techniques, such as Agent Oriented Software Engineering (AOSE) which may be equally applicable and useful when used in conjunction with, or as an alternative to other RE techniques. The combined use of Goal modelling with AOSE techniques will be presented in Chapter 7.

Classification of goals & requirements

An explicit set of goals or strategies for ML and the integration of MDTs in learning are sometimes missing from teaching and learning strategies or policies (MMUnion, n.d.; Dahlstrom & diFilipo, Walker et al, 2013). Many institutions would often specify a goal for technology infrastructure provision and support, of which it is assumed technologies supporting ML may be a part. It is proposed in the review of this thesis a specification is necessary to move the agenda forward. This may be explicit or inferred from other goals or strategies. Unfortunately, such considerations have so far been glaringly omitted in the past as may be supported by an ECAR study which found only 18% of UK HEIs report there is a formal strategy for supporting BYOD schemes (Dahlstrom & diFilipo, 2013). Considerations for security and requirements for staff development training are also assumed to be lacking in BYOD scheme implementations (Lennon, 2012; Dahlstrom & diFilipo, 2013).

Goals and requirements for a system may sometimes be classified as *soft* or *hard*. Soft goals describe objectives that are more ‘desirable’, less precise and therefore subjective; while hard goals are usually specific. Consequently, hard goals are sometimes also referred to as functional specifications for the system. For example, specifying requirements for obtaining an educational qualification, ‘*passing the assessment examination*’ may be a “hard” goal / requirement but ‘*passing the assessment examination with distinctions*’ is not. ‘Passing’ is required but ‘passing with distinction’ can only be classified as a ‘soft” goal (Donzelli & Bresciani, 2003; Berenbach et al, 2009; Lamsweerde, 2001).

Therefore, at the top-level, most goals and requirements can be categorised into *functional* or *non-functional*. Functional requirements represent functions or actions that the system or part of the system must perform while non-functional requirements are those that measure how well those functions have been performed. While this categorisation is well suited to systems resulting in an end-product, it can be possible to miss other variances within some systems if they are not classified further and ML system may be an example.

When the root problems in a system have not been established or agreed by stakeholder groups, goals are often unclear and subjective. RE techniques used must therefore be able to not only identify the root problems and specify requirements, but also specify goals for the system. Identifying the factors, issues and strategies within the system may be more relevant in this case. They are also particularly suited for classifying soft goals and requirements, especially those that are subject to many interpretations. It is also possible to develop use cases that can be used in testing the system from developed use case scenarios, which can be generated from the factors.

Factors, issues and strategies

Factors, issues and strategies are techniques used in global analysis; an RE methodology used to categorise “soft” goals and requirements that may not quite fit well into the functional / non-functional categorisation (Berenbach et al, 2009). Lamsweerde (2001) defines these as those whose “*satisfaction cannot be established in a clear-cut sense*”, as opposed to “hard” goals / requirements “*whose satisfaction can be established through verification techniques*” (pp. 3). Global analysis is particularly suited to systems that need to be examined from several perspectives and involving many different groups of stakeholders.

Another advantage of using these categorisation techniques is they can help in addressing concerns and barriers within the system when used early in elicitation process. Classifying all the information gathered during global analysis into factors, issues and strategies may also simplify the ranking process, making it easier to prioritise goals and requirements for the system.

Factors are different from requirements, in that they do not exactly describe the system but may relate to the context or a component of the system. For example, a student stakeholder stated "*I have a Blackberry but I can't use it properly and I can't sync it with my MacBook*"; relating to the effective working of part of the system and achievement of the goals rather than a requirement of the system. This statement reveals a few factors:

- Synchronisation with a PC / laptop is a desired requirement.
- Some devices (e.g. Blackberry) may not sync properly with some PCs / laptops (e.g. MacBook) … OR … some students may be unaware of how to sync some devices (e.g. Blackberry) with some PCs / laptops (e.g. MacBook)

Factors are sometimes referred to as Quality Attribute Scenarios (QASs) in a general sense which will normally have related use case scenarios defined so that requirements can be linked to them and tested. When there are conflicts in factors, it is classified as an *issue* and where there are issues there will likely be factors to be identified and *strategies* to address the issues. These may be indefinite, later to be confirmed within the architectural model for the system. An example of an issue can be seen in the following statement from another student stakeholder:

> *"I would use my smartphone if I was desperate as in location difficulty; internet access is limited in some places. However due to the small size of the screen I would prefer to use a tablet or a PC."*

The above statement technically an issue for the goal of the system can reveal several factors:

- Internet access is limited in some places
- Small size of the screen
- There is a preference for tablet or a PC

This example has also shown how factors inherent within issues can be identified and categorised.

Quality Attribute Scenarios (QASs)

QAS is another RE technique for categorising information obtained during the elicitation process. The importance of using QAS to further categorise information was mentioned briefly in previous sections. QAS is recommended in architectural requirement engineering in general for collating concerns from stakeholders and categorising them. They provide a "*structured textual*" way of managing stakeholder concerns and describing how it may respond to the introduction of certain stimulus (Berenbach et al, 2009, pp. 143). A QAS may have the following properties: stimulus, origin or source of the stimulus, artefact to be stimulated, stimulus context or environment, response to the stimulus and response measure i.e. satisfactory response to the stimulus.

For example, consider the following scenario in an ML system:

> *"In a BYOD scheme, a student requests support for a new type of device after staff training for known systems have been completed. An IT service support staff was able to figure out how to resolve the student's problem without any need for costly support from the device manufacturer nor was there any significant delay in supporting the student. The staff documented the process and trained other staffs to support similar devices within one week."*

The above example can be categorised into QAS parts as follows:

Stimulus: Support request for a new type of device.
Stimulus source: A student.
Artefact: The system and the IT service department.
Environment / context: After staff training for known systems have been completed.
Response: An IT service support personnel resolved the student's problem.
Response measure: No costly support was required from the device manufacturer nor was there any significant delay in supporting the student. The process was also replicable as part of operational strategies in the department within one week.

Consequently, not only can a QAS be defined for the scenario, it is also possible to derive requirements for the system, based on the QAS process:

- zero device manufacturer support
- no extra delay
- process re-engineering within one week

The following may also be inferred through the QAS process which could form part of the requirement specification:

- Since there is no device manufacturer support, there must be a limit to the types of devices that can be supported. If there is device manufacturer support in place, potentially any type of device may be supported.
- Delay in supporting the student's device may create a negative impression about the department's effectiveness.
- Process re-engineering will require a member of staff with adequate expertise to document the process and train other colleagues to carry on the process in future.
- The staff with the expertise is already a member of the university and part of the system i.e. a stakeholder within the system.

In considering the use of QAS, Berenbach et al (2009) cautions it is important to remember there will likely be changes to stakeholders' priorities and to ensure use case scenarios are defined in addition to QAS.

Use case analysis and scenarios

Use case analysis is a process modelling technique used to analyse processes so that the relationship of the process within the system to external systems or components can be evaluated and understood fully (Berenbach et al, 2009). Like a QAS, use cases have several parts as follows:

- Actors / users, interacting with the use case.
- Events depicted in the system causing the use case to occur.
- Pre-conditions that must be true for the use case to occur.
- Post-conditions that must be true after the use case has completed successfully.
- Activities within the use case.
- Included use cases for other processes, if any.
- Extended use cases for (optional) processes while the use case is occurring.

(Berenbach et al, 2009, pp. 59)

Use cases are sometimes better defined using scenarios. An activity diagram can also be used to define all possible scenarios within use cases. In a QAS, scenarios involved may include those occurring during normal operations, system-as-objects i.e. passive objects, growth i.e. dealing with changes, and exploratory i.e. dealing with scenarios that are unlikely to occur.

Using goal-oriented modelling techniques

Goal-oriented modelling are useful techniques for defining the goals of the business which can be associated with the requirements and needs of a system. They are particularly useful for revealing the relationship between the business goals of the system and functional as well as non-functional requirements of the system. A review of literature has revealed that one of the problems for the sustenance of ML is the difficulty in quantifying benefits when used within a learning process. Defining business goals for the system could be a useful way of establishing relevance in the strategic operations of a learning establishment.

Goal modelling are often used with Quality Assessment Methods (QAMs), which is a measure of how the defined goals meet the desired quality expected of the system. QAMs can be used as checklist for guiding against the omission of important non-functional requirements. The goal modelling technique presented in the review of this thesis illustrates how QAMs can help determine when a non-functional requirement is not "*feasible to implement*" (Berenbach et al, 2009, pp. 50).

There are many approaches to goal-oriented modelling. Berenbach et al (2009) believe KAOS approach is one of the most commonly used and Green (n.d.) added it is "*the most formal application of the goal-oriented approach*" (pp. 15). The goal of the system can be represented by factors, and issues are derived goals that meet the requirements of the factors. Berenbach et al (2009) refer to these as "issue-goals" and described the dynamic as that of developing a product (solution) that "*satisfies a particular combination of factor-goals*". When used within the system, strategies can be decisions contributing the satisfaction of *issue-goals* and *factor-goals* (pp. 153). An example of this relationship can be seen in Figure 4.2.

Like any other component of a system, factors, issues and strategies need to be managed or catalogued, or they might grow into unmanageable levels in global analysis, "*vulnerable to analysis paralysis*" (Berenbach et al, 2009, pp. 154).

4.2.2. Deriving requirements for ML from goals: A case study

There could be a disparity in what an organisation define as business goals and what is actually offered in practice. This can sometimes be very costly, leading to losses in revenue and / or goodwill branding as well as inefficiencies. Defining and implementing Quality Attribute Requirements (QARs) may guide against this or minimise the likelihood of devastating differences. Using extracts from the policies and strategies proposed in a white paper by a UK HEI, some of these issues will be explored, as well as how RE techniques may be applicable.

The HEI is located in London, UK with campuses in the East. Relevant policies in a strategy document include the following, specific areas of relevance highlighted in bold texts:

- We will ensure that our campuses are an identifiably academic environment with innovative provision for **digital ML** and **spaces for both collaborative and reflective study**.
- We will be recognised as a leading university for employability and enterprise, routinely exceeding benchmarks and providing transformational opportunities.
- In all of these areas we will seek to be at the forefront of **removing barriers to progression** to further study for first-generation undergraduates, supporting access to employment and postgraduate qualifications. In this way, and others, we will facilitate **greater student competitiveness in employment markets** and subsequently through **CPD for promotion and career enrichment**.
- In developing a more flexible offer for a more distributed, more mobile and more time-conscious market, we will enhance our distance learning capacity, partnerships and support mechanisms. In particular, we will seek to double our recruitment of new distance learning students by the end of the decade and establish a clear position as the leading distance learning provider in the UK after the Open University.

- We do not intend to invest significant amounts of capital in these ventures, but will explore a range of collaborative models in partnership with established and new high-quality providers.
- Over the period of this Strategy, when core, full-time undergraduate numbers are likely to remain restricted, there is a **greater need than ever for us to deliver our programmes at times and in places which suit the learner**. Both **teaching and support need to be flexible** so that students can access them appropriately.

(Source: Policy white paper of a UK HEI)

In deriving requirements from goals, Green (n.d.) suggests a successive decomposition of the goals at the high level. The author recommended using adapted notations to decompose each goal into sub-goals where either all or at least one of the sub-goals will need to be achieved for the high-level goal to be satisfied. When all sub-goals must be satisfied, this may be indicated with an arc across the directional arrows. Some goal components may also become sub-goals / requirements for the system. This resulting model is sometimes referred to as goal hierarchy or goal lattice (Green, n.d.). An illustration can be seen in Figure 4.1, representing a subset of goals identified and extracted from the strategies outlined in the policy white paper of a UK HEI listed previously.

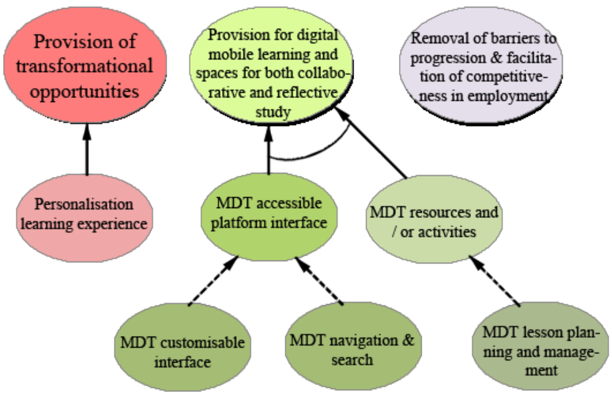


Figure 4.1: Subset of goal decomposition from business strategies

There are several taxonomies for defining QARs including ISO 9126 containing 22 quality attributes. These include for example the use of ambiguous terminology in definitions (Berenbach et al, 2009). Some of the statements in the policy white paper may fall into the category of those needing more clarity and less ambiguity. Berenbach et al (2009) suggests an integrated approach to defining QAR for a system i.e. defining QAR from an integrated requirements model involving all the functional requirements and architecture of the organisation's operational system. For this, the authors recommend the use of an integrated artefact model (see Figure 4.2) as well as goal models to show the artefacts within the system. The relationships linking the functional and architectural requirements could also be depicted in the models.

4.2.3. Integrated artefact model

Once the requirements and goals of a system is specified (see Figure 4.1), an integrated artefact model architecture can be created to show the relationship between the classified objects as well as the attributes within the system as shown in Figure 4.2. Defining the relationships between each of the artefacts within the system will make it possible to define QARs for the system. Relationship of the objects within the system to *factors*, *issues*, *strategies*; placement of test cases as well as how QARs may be applied to use cases, scenarios and functional requirements can be specified. An integrated artefact model architecture will also allow for "*trace relationships*" which are sometimes overlooked to be clearly defined and established (Berenbach et al, 2009, pp. 130).

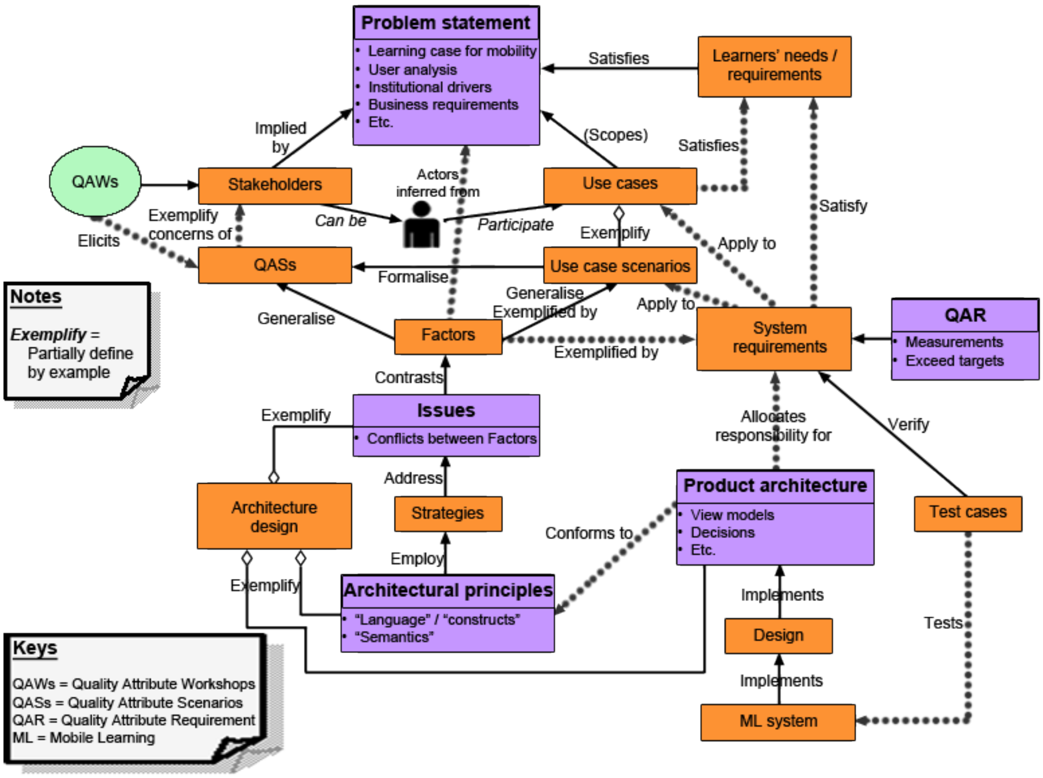


Figure 4.2: Integrated artefacts model architecture for Mobile Learning (ML) (Berenbach et al, 2009, pp. 130)

Artefact models are particularly useful for aligning project goals within the broader goal(s) of an organisation. Symbolic notations are often used in some artefact modelling to illustrate relationships between the objects. Some may be defined using predicate logic language involving the use of symbols, quantifiers and logical operators. For example, the predicate *equal(A, B)* indicate A = B; *plus(A, B)* indicate A should be added to B and so on (Lakmazaheri & Rasdorf, n.d.). Using techniques such as predicate logic language notation for artefact modelling can however render the model too complex for those without expert knowledge on the subject (Ullah & Lai, 2011). Therefore, relatively simpler notations specified in the *i** framework for AOSE by Eric Yu will be employed and illustrated in Chapter 7 for ML system.

Integrated artefact modelling can be simplified by using standardised object relationship notations commonly used in computer system modelling to reveal how the components of a system may be dependent on each other, guiding requirement specification for the system (Berenbach et al, 2009). To illustrate, an integrated artefact model architecture showing how components within the problem statement for ML is shown in Figure 4.2. The model shows when QAWs, QASs and test cases may be required for the system. It also reveals when QAR may be needed to guide against extreme differences in opinion among stakeholders. Use cases will need to be established for testing how well the requirements achieve defined goals as well as the functional / non-functional specifications.

Textual descriptors have been added to describe the relationships between the components of the model in Figure 4.2 for clarity. Used alongside a full goal model specification of the components in Figure 4.1 and other relevant system requirements, it should now be possible to elaborate on goals for the system. Requirements can also be specified and use cases defined for testing how well requirements may achieve goals, functional and non-functional specifications.

4.3. The challenge of using RE for ML systems

In this chapter, the proposed use of RE techniques to explore issues in ML and the relationships between MDTs and education have been presented. Chapter 6 will present the findings of the process as well as subsequent discussions arising from the review of this thesis. In Chapter 7, conceptual models derived as a result of the findings will be presented. While RE techniques can definitely be of some considerable benefits when used in systems such as ML, the complex nature of the environment makes their use a very challenging prospect, as may have been outlined in this chapter.

As well as establishing requirements, the review of this thesis addresses a peripheral question in the wider context exploring how a co-evolution relationship between MDTs and education may impact these requirements and goals. Currently, stakeholders in the educational community would appear to be playing catch-up with MDTs. What might it be like to have the agenda driven by needs and requirements identified in education in the first instance, and how likely is that scenario able to achieve learning transformation? This will be discussed further in Chapter 8.

Chapter 5

No longer is it possible for modern man, individually or collectively, to live in any exclusive segment of human experience or achieved social pattern. The modern mind, whether in its subconscious collective dream or in its intellectual citadel of vivid awareness, is a stage on which is contained and re-enacted the entire experience of the human race. There are no more remote and easy perspectives, either artistic or national. Everything is present in the foreground.

~ Herbert Marshall McLuhan (1911-1980)

Instructional designers need to run, not walk away from classroom-thinking ... leveraging new technologies to deliver non-traditional instruction.

~ Prof. Karl M Kapp, Bloomsburg University

UK HE ecosystem: Learning in the 21st century

5.1. Education in focus

Higher Education (HE) sector is considered "*a core strategic asset to the UK*", impacting "*education, research and innovation*" with wide-ranging benefits for environmental, economic, cultural and societal developments (HESA, 2013, pp. 2). Operational contexts in Higher Educational Institutions (HEIs) are increasingly complicated, extending well beyond teaching and learning which remains the core business. The situation is intensified by the necessity to respond effectively to far-reaching rapid technological changes on a regular basis. Thus, HEIs in the United Kingdom (UK) have probably never faced more difficult challenges.

UK government reforms to funding strategies for undergraduates is a major source of some of the more recent challenges with implications yet to be grasped in its full entirety (HEFCE, 2013). O'Prey theorise universities must be prepared for uncertain times ahead (O'Prey, 2013). In Chapter 1, there were suggestions HE may not be responding to increasing presence of MDT among students as robustly as they should (Walker & Voce, Aoun, 2014). This chapter explores the UK educational ecosystem, presenting a brief snapshot of the dynamics operating around teaching and learning delivery / provision in HEIs.

The chapter begins with a brief reflection on current educational system as well as likely driving forces behind infrastructure provisions (or lack, as the case may be). Much have been extrapolated previously in this thesis about how today's students may benefit from MDT integration. Students' demographical profile are therefore explored in this chapter, based on the analysis of statistical data sourced from primary and secondary sources. Relevant quotations from some of the stakeholder participants in the review of this thesis are also presented. More results and findings from the review will be presented in Chapter 6, with specific aspects modelled and discussed further in Chapters 7 and 8.

5.2. A snapshot in time: HEI stakeholder demographics

Among other things, HE sector is also tasked with the provision of skilled workers and talent for both HE and other sectors within UK's GDP (Gross Domestic Product) profile. Through its Postgraduate (PG) and Undergraduate (UG) programmes, skilled workforce are generated, who in turn contribute to the community and to the country's economy. However, there are concerns skilled graduates are currently in short supply across the world. According to Aoun (2014), the demand "*for employees with the most advanced education and skills compels all of us to seek new opportunities to improve college attainment, completion, postgraduate employment and affordability.*"

This may be nothing new having become another incessant call over the ages. It is however impossible to ignore the likely impact of proficiency requirements to operate increasingly complex technologies effectively on the demand for skilled graduates. While proficiency in MDT use for learning and teaching may not of itself satisfy that demand, it has been suggested students do require particular 'sophisticated' skills; specifically those affording the ability to utilise a complex array of innovative technologies including MDTs skilfully (see Figure 5.2). It has been suggested further these skills among others are crucial in supporting 21st century learners; now expected to be capable of seamless learning prowess across contexts (Kukulska-Hulme et al, 2007; cited in Gordon et al, 2014).

The relationship between MDT proficiency and skill acquisition will be examined more closely in Section 5.4 of this chapter. It may be useful to mention here the notion of HE as skilled workforce supplier is a bone of contention of sorts between those demanding quality skilled workforce and those holding to the ideal of education for its own sake. Noticeably, the clarion calls and concerns HE may need to prioritise commercialism in the years to come while 'real' learning suffers have gained more solid grounds of recent (IPPR, 2013; Delargy, 2014; Stevenson & Mercer, n.d.).

Nonetheless and whatever ideal is held onto, the core players within HE remain the students as both main service users and value-added product of the system. They have also become important funders of the UK HE sector through tuition-fee payments and as potential tax-payers; given HEs are still recipients of some public funds. Thus, exploring the demographical profile of current students may not only reveal the nature of their MDT ownership but also how easily they are able to access or have preferences for ML and / or TEL when enrolled in an HEI.

5.2.1. HE students demographical profile

Demographical make-up of students have been suggested as both a driver and a barrier to MDT integration. On the one hand, it is believed there is a large proportion of adults of certain age groups commonly called the millennials or generation Y (typically referring to those born between 1980s and 2000s). In the past, clichéd labels such as “net-gens”, “digital natives”, “digital agers” have been used, the latter believed pioneered by Marc Prensky ('Digital native', ‘Millennials’, 2014). The assumption is adults in this age group are more likely to expect TEL.

However, it has also been suggested the assumption you are young and therefore competent on technology is flawed. An academic suggested,

> *“I think the idea of digital natives / immigrants did a lot of damage and I don’t think Marc Prensky meant it to … To an extent it may be assumed that if you are young you can handle technology more competently but that’s not always the case.”*

Traxler (2010) saw the issue differently, suggesting students’ proficiency and competency on MDTs and technology is proving to be a nightmare scenario for some educators, “*one of loss of control and loss of the quality, consistency, uniformity and stability that delivered the dreams of equity, access and participation*”. He added the fact MDT “*allow students to produce, store, transmit and consume information, images and ideas*” would be a dream scenario in an ideal world since it should be potentially easier to achieve learning objectives; but it is far from being one (pp. 149).

As far as educators’ fear of loss of control goes, Traxler is not the only one to have noticed this phenomenon. An academic participant also admitted this may be a problem, suggesting it may also concern making learning content available for learners:

> *"From a lecturer's point of view, there is probably still a bit of anxiety about letting go of that traditional 'ownership' of that content, and the feeling that you want the recipients or students to take that on board and use it in a certain way."*

Either way, HEIs may of necessity be required to conduct regular demographical studies of students in their institutions and determine what services / provisions are needed and how students may be affected by or respond to the services and provisions on offer. As Beer (n.d.) puts it, MDTs "*are pervasive in contemporary society*" and therefore, "*new operating practices are gradually emerging as the sector adapts to its changed role in the 21st century knowledge economy*". Beer (n.d.) noted academics and other stakeholders in HEIs may experience increasing pressure to integrate technolog(ies) as a consequence, stating:

> *"It is evident that students entering HE expect universal Internet access, support for using their own equipment within the university, and comprehensive access to learning … which can place serious time management pressures on staff."*

The notion of the millennials and 21st century learners will be explored later, in Section 5.5. Among issues of particular relevance will be the pedagogy and learning space that may be more beneficial to students in an ML environment.

5.2.2. Teaching, learning and learning support

Given Fisher (n.d.) is of the opinion staff / student ratio may be a problem for learning enhancement as outlined previously in this section, it may be useful to explore the ratio between teaching staff and students in HEI. There was a total of 185,585 academic staff according to HESA's SFR report for the academic year 2012/13, an increase of 2% over the number of staff on academic contracts in UK HEIs from the previous year (see Tables 5.1 and 5.2). This was in contrast to 2,340,275 students enrolled across the UK for the same academic year, suggesting a ratio of 1 staff to 12 students.

Although not likely to be applicable in all subject disciplines or modules, this ratio, admittedly found to be extremely variable in many cases, may suggest there is a likelihood of the type of pressure suggested by Beer (n.d.) to occur if all academics were compelled to embrace MDT integration.

Table 5.1: Categorisation of all staff (2012/13)

Activity	Full-time	%age F/time	Part-time	%age P/time	Total
Academic staff	122500	66.01%	63085	33.99%	185585
Managerial, professional & technical staff (non-academic)	70815	78.56%	19330	21.44%	90140
Clerical staff	40880	63.20%	23805	36.80%	64685
Manual staff	20300	48.21%	21805	51.79%	42105
Total	254495	66.53%	128025	33.47%	382515

Competency of academic and IT service staff in a sustained MDT integration and support is therefore another area of some considerable concern. Winters & Mor (2008; cited in Belshaw, 2010) maintain "*designing authentic, engaging and useful*" ML "*contexts can be challenging, requiring the assimilation and integration of deep knowledge from educators, researchers, practitioners, designers and software developers*" (pp. 57). It is unlikely a single individual will be able to demonstrate such wide-ranging expertise, the authors add. Woodill (2011, pp. 215; cited in Belshaw, 2010, pp. 57) agree, identifying three main barriers to integration as:

1. *Lack of expertise in mobile instructional design.*
2. *Lack of awareness of the full scope of costs, benefits and risks.*
3. *Conflicting accountabilities, interests, and procedures among content stakeholders (learning creators and business budget holders) and IT implementers / supporters.*

Belshaw (2010) adds "*conflicting interests and accountabilities*" may impact several areas of operation across the institutions. For example, ML proposals and initiatives may be restricted in an environment where the "*first priority*" of IT service "*is the integrity of the institutional network*". In a recent comparative study, academics and those in the role of learning support and governance rated "*IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs)*" and "*staff development training on content delivery and ML*" as the top two measures to be prioritised in an ML environment. Belshaw (2010) suggest there is necessity for IT support buy-in.

Table 5.2: Full time academic staff (2012/13)

	Full-time					
	Female	%age Female	Male	%age Male	Total	%age Total
Academic employment function						
Teaching only	5090	10.88%	5640	12.05%	10730	22.93%
Teaching and research	27615	29.19%	48095	50.84%	75710	80.03%
Research only	14935	35.27%	19875	46.93%	34810	82.20%
Neither teaching nor research	515	27.99%	740	40.22%	1250	67.93%
Total academic staff	48155	25.95%	74350	40.06%	122500	66.01%
Contract level						
Professor	3175	17.76%	11610	64.93%	14785	82.69%
Not a professor	44980	26.82%	62735	37.41%	107715	64.23%
Terms of employment						
Open-ended/permanent	34655	28.98%	56980	47.64%	91635	76.62%
Fixed-term contract	13500	20.46%	17365	26.31%	30865	46.77%

Institutional policies, operational strategies and culture may also be insurmountable barriers to MDT integration. Considering what the authors term "Bring-Your-Own-Everything (BYOE) era" in HE, Dahlstrom & diFilipo (2013) suggest there may be no specific policies for MDT integration per se, but there are typically generic policies, specifically relating to "*IT security and expected user behaviours*" (pp. 14), which may either be too restricting or lenient to be of use in a BYOE environment.

The authors advocate robust BYOE implementations in HE because "*students are able to use personally selected and maintained technologies to leverage … connectivity for instructional opportunities, whether in the classroom or wherever they are, all of the time*" (Dahlstrom & diFilipo, 2013, pp. 3). A summary of recommendations for effective BYOD and / or BYOE schemes by the authors are presented in Section 8.5 in the review of this thesis.

5.3. Students' motivation for HE and experience

The phrase "student experience" may be a catchall and almost clichéd, it is still a desirable goal in most HEI. Some members of the educational community and learning establishments would prefer to avoid using the phrase as a measure, preferring terms like "learning outcome" or "overall educational experience" etc., which includes or prioritises educational achievement. For example, a Deputy VC told the review of this thesis:

> *"I talk about outcome, not experience. And I am making a very important distinction here ... because I don't for a moment say student experience is not important – it is very important. But I think it is trumped by outcome ... you can have a great experience but if the outcome is failure, you'll look back on it and it will not be a good experience … So, I have begun to coin the phrase 'student outcome'."*

There are however scores of literature and suggestions on the placement of student experience in strategic policies of learning establishments; maintaining it should be prioritised (Dahlstrom & diFilipo, Kandiko & Mawer, 2013). Students starting in HE armed with some direction and motivation already may have clearly defined objectives. Others may need further help and direction. Either way, while universities serve a multi-faceted and somewhat complicated purpose in the community, developing motivation in students may arguably be one of the most important task for educators (Kukulska-Hulme, 2010; CET, n.d.).

Table 5.3: Motivations for university education

Categorisation	Count	%
Professional / career / income / make a difference / self-ambition	54	27.27%
Learning / interest in subject / HE experience	40	20.20%
Expectations (parents etc) / family or peer competition	30	15.15%
To leave home / independence / fresh start or avoid a bad experience	28	14.14%
Social experience (party or enjoy life) / make friends	21	10.61%
Avoid working / not sure what to do yet	10	5.05%
Other	7	3.54%
No other option / nothing else to do	5	2.53%
Grow / maturity	3	1.52%
Total number of reasons	**198**	

Thus, HEIs in general would commit considerable part of their annual budget and effort into learning and teaching as well as motivating students to achieve. The ultimate hope is at the end, students will also achieve their own goals for higher education, whatever those may be. Consequently, a starting point for those recommending a determination of what students' wants may be why students choose HE education.

Preparation of young adults for the world of work is often assumed as students' motive for higher education, but one denigrated by those holding to the ideal learning should be for its own sake. "*If students are merely there to serve the job market, then free academic inquiry is just a waste of time*", stated Delargy (2014), in support of the latter. Delargy (2014) berated Irish universities scathingly, suggesting they are "*following their UK and US counterparts down a path of increasing commercialisation*".

It is clear the author believe turning out students just for employment is not a noble enough reason for higher education. Nonetheless, the item was top of the table for 27% of 107 HE students contributing to an online forum on The Student Room in February 2012. Although there are a myriad of reasons students go to universities, some more predictable than others, professional career was chosen as the top motivator in this instance. In total, the students gave 198 reasons, some supplying more than one, categorised in Table 5.3 and presented in a pie chart in Figure 5.1.

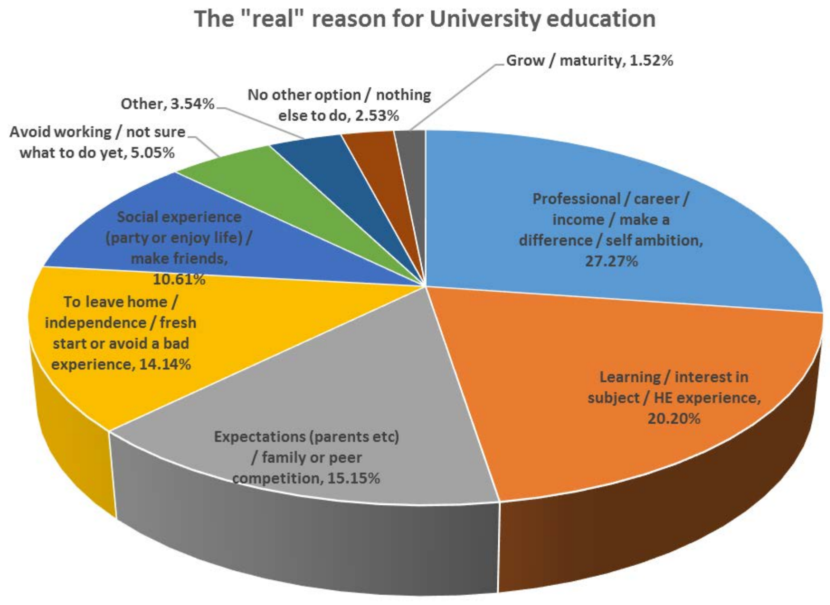


Figure 5.1: Students motivation for university education

The position of those wanting a professional career at the top of the table (although accounting for only 27%) would seem to indicate Irish universities and UK HEIs may have embarked on policies they feel could satisfy those aspirations. A few of those wanting a career add they want to make a difference in their chosen career, suggesting perhaps there is an interest in their chosen field of study or in learning also. Some of the comments include the following:

> *"To enhance my prospects of getting a well-paid job. I'm not really interested in education, and wouldn't even say my subject is something I'm that passionate about. I'm someone who would have dropped out of school at 16 if it was a viable option."*

> *"I went to uni [university] through clearing 20 years ago and hated it, so dropped out. So I've worked hard for the last 20 years, and not got that much to show for it, and now have the opportunity to study what I wanted to study in the first place, where I wanted to study it."*

However, the table (Table 5.3) and pie chart (Figure 5.1) did show there are several other decisive motivators including those wanting higher education to learn more about their chosen subject or for the sake of learning, accounting for 20% of the reasons given. What may also be clear is training students and preparing them for the world of work as a motivator is perhaps impossible to ignore for many in HEI and in the community.

More importantly, without suggesting this data is representative of UK student population, the findings would seem to indicate majority of students come to HE with some form of motivation at the very least. It has been suggested those motivations tend to fluctuate as students proceed through the rungs of their HE programme ladder (Darby et al, 2013; CET, n.d.), sometimes "*determined by the characteristics of the … environment*" (Wang, n.d.; cited in Berrett, 2012). Consequently, sustaining students' motivation at an acceptable level that will assist them in succeeding at their course programmes has probably never been more vital to any self-respecting HE (O'Prey, 2013).

According to Belshaw (2010) and Kukulska-Hulme (2010), this is another area in which MDTs may be able to make a difference. Beer, the VC of Oxford Brookes University agree, suggesting the following measures as necessary; already seen as being implemented across UK universities by Beer (n.d.):

- Work spaces that match students' expectations.
- Learning styles promoted by digital technologies.

- Re-thinking the construction of traditional library to support professional competencies as staff come to terms with rapid growth of digital information / technology.
- Use of digital technology to improve assessment, feedback and staff / student interactions and to support self-directed learning.
- Satisfying employers' / customers' expectation for obtainable and / or electronically delivered information.

Source: Beer (n.d.)

It is necessary to also mention, as noted by Kandiko & Mawer (2013) among others, that students "*value face-to-face interactions for learning and support*" and view technology only "a*s a means to access resources and support studying*". The authors caution any technology integrated in learning should not be "*replacement for face-to-face interactions, or as a substitute for developing an active and collaborative learning environment and community*" (pp. 9).

Kukulska-Hulme (2010) agree, suggesting MDT should be used "*inside and outside the classroom*", learning seamlessly across contexts as students are now expected to; in lecture theatres, the field, laboratories, seminar rooms, personal workspaces, online / VLE (Kukulska-Hulme et al, 2007; cited in Gordon et al, 2014, pp. 2). The author added expectations of learners are changing "*due to the pervasiveness of technology*". Another driving motivation, the author believe, is the knowledge learners have these tools with them all the time which may therefore act "*as a catalyst for an inquiry into learner preferences, skills and study behaviours*" (Kukulska-Hulme & Pettit, 2007; cited in Kukulska-Hulme, 2010, pp. 5).

5.4. A radical paradigm shift for teaching and learning

Paradigm shift, *transformation*, *innovation*, *restructuring* are some of the calls synonymous with educational processes for perhaps decades. Global downturn in the economy has resulted in the necessity for greater demand for efficiency, value for money and increased accountability (Fisher, n.d.). In response, incumbent governments and HEIs have attempted reforms and strategies which included encouraging flexible and online learning modes (Gerhard, 2005).

Furthermore, the 2012 funding reforms have meant universities will also have to compete with non-traditional learning providers in a move towards what has been termed '*de-institutionalisation of education*' (Knowles, 1975; cited in Ashworth et al, 2004, pp. 14). Reporting there is already a decline in the number of part-time learners and advocating continuous monitoring, HEFCE maintain the reforms are "*means to an end*" listed as improving:

- quality of learning and teaching as well as student experience,
- capacity to undertake speculative, ground-breaking research,
- ability to build on enviable record of knowledge exchange, tackling societal problems and promoting economic growth.

Source: HEFCE, 2013

HEFCE acknowledged there could be more impact on undergraduate and postgraduate intakes in the near future. Years earlier, Knowles (1975; cited in Ashworth et al, 2004, pp. 14) recognised one of the core functions of universities today as creators of "*employment opportunities*", suggesting the '*need for learners to develop appropriate skills*' has probably never been so essential. In an online blog, McGreal (2014) would support this view, considering the issue from another perspective and asking a vital question: "*Why does the UK education system remain at a stand-still, while business is moving and the skills-gap is widening?*" The author concluded:

> *"A university degree may not be vital for young people to succeed in business, but social attitudes towards education need to develop alongside business. For the UK economy, vocational courses and practical skills should not be second to a university degree."*

It may be argued proficiency in MDT use, or as Dahlstrom & diFilipo (2013) puts it, the ability to be able to use these technologies for "*instructional opportunities, whether in the classroom or wherever they are*", may be a critical skill, not only for negotiating learning in the connected classroom ecosystem (see Figure 1.3) but also for achievement of a university degree. Beyond that, it may also be argued those skills may, albeit in part, also contribute to excelling in world of work and occupying viable roles and responsibilities within the community. After all, MDTs are first and foremost communication tools, effectiveness of which is essential in any establishment.

Perhaps in recognition, Beer (n.d.), current VC of Oxford Brookes University contend there are radical changes, certainly for the better, necessary and currently occurring in HEIs across the UK; stressing "*new operating practices are gradually emerging*". For Aoun (2014), writing for Times Higher Education, the desired paradigm shift is more to do with going "*beyond the limits of traditional learning*".

The author noted there are "*teaching and learning innovations*" which could "*offer the possibility to help resolve the great challenges facing higher education, including the pressing challenge of cost*"; and according to Aoun (2014), many HEIs (in US and Australia) are not taking advantage of this. The writer explained the rationale behind this thinking process:

> *"Adaptive learning systems, experiential learning, competency-based approaches, programmes that offer alternative credentials, courses that are accessible on mobile devices and educational partnerships with employers all personalise higher education. They allow students to tailor their learning to fit their needs, their learning styles – and, just as importantly, their budgets."*

Agreeing with McGreal (2014), Aoun (2014) believe there should be additional motivations to advocate change besides reducing budgets for both students and learning establishments. A preferred goal and a likely catalyst for paradigm shift in education for both authors would be an environment which allow "*students to tailor their learning to fit their needs, their learning styles*", leading to what Aoun (2014) termed 'personalised higher education'. In the quotation above, MDT integration seem central to such a scenario.

This leads conveniently to an important area of consideration for this research examined briefly in Sections 1.3.1 and 2.4.2: How can learners be motivated to "deep learning" and what role can MDT play in this process? Are today's learners "*under-researched and imperfectly understood*" as JISC (2007; cited in Kukulska-Hulme, 2010, pp. 7) suggested? And the Holy Grail: Can MDT integration in learning and teaching transform HE education? In the next sections, an attempt will be made to consider some of these issues more and how MDT integration may play a role in solutions to the perceived attrition in learning and teaching, and to effecting learning transformation

5.5. Understanding the inquisitive mind: The learners

Higher Education learners are considered adults, primarily defined by age. The assumption then is they are independent, self-directing with defined motives for higher education (Penn State, 2007). Fry et al (2009) agree, finding majority (66%) of 844 university student respondents to a survey did have a motive for enrolling. The authors classify these as those with '*means-to-an-end*' (pp. 27)). Examining pedagogical issues in relation to e-learning, Mayes & Freitas (n.d.) suggest academic understanding, general competencies, reflection and skill as learning attributes applicable to HE learners in general (pp. 11-12). To these, Fry et al (2009) add full and relevant feedback is essential.

Critically considering adult learning theories, Fry et al (2009) question whether there is a difference between the ways adults learn from that of children, suggesting there is no empirical evidence to support the idea. They however admit adult learning theories may be more beneficial for students with diverse demographics i.e. '*age, mode of study, ethnic, economic or educational background*'. Penn State (2007) agree, adding other factors such as '*delayed post-secondary*' enrolment, financial independence, parenthood, personality, work (part-time / full-time) etc., may also be differentiators.

Learning theories and paradigms have historically influenced learning processes over the ages, perhaps creating more problems than it solved (Spear, 1978; Pritchard, 2009). Some of the criticisms levied against them include their inability to deal with special needs or conditions that may fail to follow prescribed assumptions of 'normal' learning situations (Pritchard, 2009). Regardless, adult learning theories and adult education have a toehold in university learning, influencing many of the methods and techniques employed.

Using the term andragogy, Malcolm Knowles defines adult learning as the '*art and science of helping adults learn*'; a definition that has since been changed (Knowles and Associates, 1984; cited in Fry et al, 2009, pp. 14). Paradigms with basis in adult education include self-directed, experiential / situated learning, meta-cognition and critical reflection as suggested by Penn State (2007). Some of the most popular learning theories influencing HE learning and teaching are commonly known as behaviourism, humanism, cognitivism, social learning and constructivism etc.

HE learning and teaching tends to adopt techniques lending themselves to a combination of these theories. Crucially, Fry et al (2009) suggest some academics are unaware of how their students learn nor do they reflect on whether learning occurs through teaching methods used. Penn State (2007) seem to agree, adding there seem a preference for "*semester-bound, campus-based lecture-driven education*"; advising on avoiding these for assessment or "*curriculum / course design and delivery*".

In that sense, learning and teaching in HE remain more or less the same as it has ever been as demand for places is projected to decrease due to higher fees from 2012-13. Fry et al (2009) theorise experiential learning should underpin any method / approach selected. The question for the review of this thesis however is whether MDT could play a part, and if so, in what manner? On that note, Ashworth et al (2004) believe opinion advances and availability of sophisticated technology will be an important feature of future learning modes. The authors add increase in competition and reduction in public funding will force the issue on the need to understand better how students learn.

Other factors affecting learning dynamics, identified by Ashworth et al (2004), are assumed to be "*globalisation, modularisation, mobility of learners, distance education / e-learning / flexible learning, lifelong learning, mass education and work-based learning*" (pp. 9).

5.5.1. 21st century learners

At the core of every call for learning transformation is often the call for more control given to the learner, which may have its root in Kolb's experiential learning theories (Kolb, 1984). The IPPR (2013) report admits this is also a motivation for government-led reforms in education over the years. An obvious question may be how much control is needed and how might it be implemented more effectively in an ML process? It has been suggested this is because of changes in definitions for learner demographics and profiles which is increasingly made up of the millennials or generation Ys (Beer, n.d.; ‘Millennials’, 2014) considered briefly earlier in this chapter. For example, HESA data on student enrolment for 2011/12-2012/13 reported 67.74% of all enrolled in HE are between 18-26 years old, and 14.70% between 27-35 years old.

McLoughlin & Lee (2008) agree with this premise, suggesting the now common and perhaps clichéd labels of “net-gens”, “digital natives”, “digital agers”, “digital age learners” etc., may provide insight into the characteristics of a new generation of learners which may be hard to ignore ('Digital native', 2014). Currently learners, they believe, are more readily familiar with accessing and processing information in short bursts, and more adept at multi-tasking than ever before (Litchfield et al, 2007; McLoughlin & Lee, 2008). Kukulska-Hulme (2010) agree, suggesting learners need to develop specific skill sets to cope, some depicted in Figure 5.2.

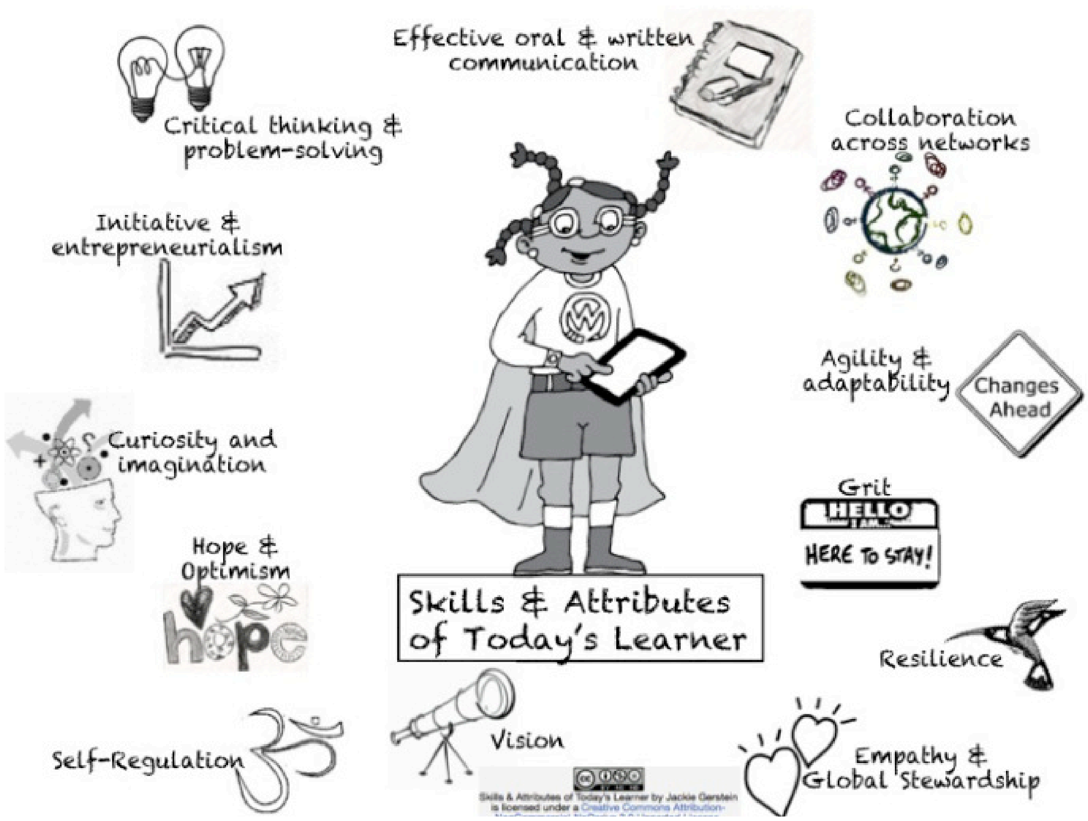


Figure 5.2: Skills required by today's learner (Gerstein, n.d.)

In Chapter 1 of this thesis, theories for how learners can be motivated were briefly introduced; as modelled in Kolb’s learning cycle and Bloom et al (1956;

cited in "Bloom's taxonomy", 2014)'s taxonomy or the concepts of deep, surface or strategic approaches to learning (see Section 1.4.1). Variations of these have often emerged over the years, suggesting the level of difficulty in reaching an acceptable solution. Prensky (2005; cited in Litchfield et al, 2007) suggested learning processes which combines several elements of interaction, including "*listening, observing, initiating, questioning, reflecting, trying, estimating, predicting, practicing and 'what-ifing'*" (pp. 588). The general conclusion therefore is there are proportions of so-called 'net generation' students in most classrooms and learning spaces across the world today who may be let down by processes steeled in old traditions.

A term that could perhaps describe these group of learners could be *mobile learners*, coined by Peng et al (2009) and derived from Hardless et al (2000, pp. 3; cited in Peng et al, 2009)'s "*mobile people*". Hardless et al (2000; cited in Peng et al, 2009) describe "*mobile people*" as those whose "*work is distributed in both time and place*" (Peng et al, 2009, pp. 176). Hummel & Hlavacs (2003; cited in Peng et al, 2009) suggest today's learners are similar in terms of their learning practice; accustomed to short interactive sessions characterised by rapid access to information. The authors argue *mobile learners* prefer to work off-line; requiring easy access to information; also agreeing with an earlier estimation by McLoughlin & Lee (2008).

Kukulska-Hulme et al (2009, pp. 11; cited in Belshaw, 2010) would add mobile learners require a "*plethora of routes through predefined subjects and curriculum content*". The author suggest this should be personalised and "*requires that learners… are also supported to become active partners in developing their own educational pathways and experiences*" (Kukulska-Hulme et al, 2009, pp. 55; cited in Belshaw, 2010, pp. 15).

Nash (2007) agree, adding learners require the ability to move and to learn while doing so. In other words, they require a fluid and dynamic learning environment; believing MDTs may offer this capability. A different perspective from Youatt & Wilcox (2008) stated a driving force may have something to do with what they call globalisation paradigm. The authors agree with the IPPR (2013) report, and also with McGreal (2014)'s and Aoun (2014)'s surmise there is a global need for “skills revolution”. More focus is required on equipping learners with the right skills set (pp. 24). Moore (2009) agree, suggesting this may explain the UK government’s earlier focus on educating '*learner workers*' to “*accommodate global markets*” (pp. 243).

However, there are warnings and concerns regarding the ever present danger of over-estimating technological capabilities of students or the proportion of millennials or digital-agers within a cohort (Minton et al, 2004; JISC, 2005; Lai et al, 2007; Dyson et al, 2009). The general fear is those less able may be neglected or disadvantaged in a technologically-directed learning process (Abdullah et al, 2013). Julie Baldry Currens, a member of the senior management team in an HEI warned in 2011 when consulted on this subject:

> *“A considerable number of our students are middle-aged and some of them have some real fear of using computers. In order to provide equitable and inclusive service to all our students, we need a culture change and a strategy that will ensure that these students are not left behind.”*
>
> *Julie Baldry Currens (2009)*

Litchfield et al (2007) suggest educators may in fact have technological competency problems, adding this should be recognised and addressed through institutional support and staff development training. A MoLeNET report (2010, pp. 8; cited in Belshaw, 2010, pp. 26) agree, suggesting “*the amount of time involved in training and supporting staff and for teachers themselves to develop their delivery to include effective mobile learning*” is “*the main barrier to sustaining mobile teaching and learning*”.

5.5.2. Pedagogy for 21st century learners and beyond

The perpetual consideration of how learning occurs and how to motivate learners to deeper, critical and reflective study in an ML process have been discussed in relevance to how MDT integration may offer some unique dimensions. Given the recognition there is a necessity to employ instructional designs capable of motivating today’s learners to deeper learning, what are the criteria for selecting suitable pedagogical techniques? As have also been mentioned in previous sections, a review of literature show an overwhelming support for learning strategies that is experiential, scaffolded, situated, authentic, personalised and autonomous; promoting self-direction and informality (Clough et al, Traxler, 2007; McLoughlin & Lee, 2008; Fry et al, 2009).

Belshaw (2010) agrees in principle, adding MDT "*can help change and refocus pedagogies*". The author went on to suggest the affordances of MDT could effect "transformation in learning activities … unlike interactive whiteboards, which perpetuate a 'stand-and-deliver', transmission model of education" (pp. 23). Affordances have been mentioned over and over again in previous chapters, and explored briefly in Section 2.4.1.

As with most concepts within ML domain it would seem, the term "affordance" or "educational affordance" seem to have assumed multi-faceted connotations. It may be used in reference to those present within MDTs as a tool or in the learning process it facilitates. For example, Lai et al (2007) list educational affordances of MDT as facilities for note-taking or images, sound and video capture, GPS etc. Woodill (2010, pp. 53; cited in Belshaw, 2010; pp. 10) however suggested seven educational affordances from the perspective of ML as a process which include: mobility, ubiquity, accessibility, connectivity, context sensitivity, individuality and creativity.

Belshaw (2010) suggests while devices could be wireless-enabled or not, an ML process requires both mobility *and* connectivity i.e. a wireless-enabled device. This reflects a growing perception connectivity is an essential criteria in an ML process and support for the expansive definition for MDT proposed in Section 1.1. The notion may also provide the differentiation assumed to be sorely required i.e. to differentiate ML from 'tethered' e-learning process and other types of learning (Traxler, 2007; cited in Rajasingham, 2010, pp. 3).

5.5.3. The learning space

Issues relating to the learning space was considered briefly in Section 1.4. If asked to design a classroom for learning today, what might it look like? Traditional classrooms are recognisable all over the world with typical features including walls, chairs and tables or desks, black or whiteboard etc.; the standard format allowing very little room for deviations from the now entrenched image of the tutor (the sage of learning) in frontal position and the learners (receptors of learning) facing the tutor in disputable 'rapt' attention. This may have been created for expediency, and may even have been a break-through at one time for facilitating mass learning. It is questionable if that's what's needed for effective learning anymore (Mulders, 2013; Aoun, 2014).

A question largely inferred in the review of this thesis is how well learners of today are served by this mode of learning. Considering a similar scenario perhaps, Mäkitalo-Siegl et al (2010) asks "*Will classrooms still exist 20 years from now?*" Given it has existed more or less as it is now for centuries, the very notion it could be done away with may be considered bold and perhaps even radical or unthinkable, depending on the preferred school of thought. The authors however seem hopeful, believing "*understanding of learning and the conditions under which it is facilitated*" has evolved over the years. They add (pp. 1):

> *"Development in technologies that can be used to enhance and support learning has been even more rapid. Nonetheless, it would appear that the majority of the classrooms in today's schools and universities remain unreached by these developments."*

While classroom features are changing, including a lot more than chairs and desks and black or white boards, the structure is much the same; leading Aoun (2014) to call for 'learning' that goes "*beyond the limits of traditional learning*"; agreeing with Mäkitalo-Siegl et al (2010) nothing much has changed. Graetz & Goliber (2002) and Tanner (2000), cited in Mäkitalo-Siegl et al (2010) suggest learning environment impacts behaviour, and consequently the learning that can occur in that environment. Years earlier, psychologists like Abraham Maslow thought the same, leading him to derive the now famous 'hierarchy' of students' needs in a learning space ("Maslow's hierarchy of needs", 2014).

The learning space is therefore considered an essential part of an effective ML process. Looi et al (2010) derived the seamless learning framework for private /

public learning spaces enabled through MDT and fostering cognitive learning for this very reason. Similarly, conceptual understanding of ML is often related to the spaces and contexts of the learning, with suggestions such spaces should be free and not fixed, fluid and untethered (Vavoula, 2005; Traxler, 2007; cited in Rajasingham, 2010), ubiquitous and / or mobile (Peng et al (2009), seamless (Yi et al, 2009; Looi et al, 2010; VanderArk & Schneider (2012) etc., to mention a few of the common descriptive attributes.

Traxler (2011) suggest spaces and contexts where "*learners can react and respond to their environment*". The author gave examples supporting situated learning such as those addressing challenges created through "*distance, scarcity and separation*" e.g. "*learning in art galleries, botanical gardens, museums or heritage sites*", use of location-aware systems to enrich learning processes etc. The author adds MDT should be "*intrinsic parts of any vocational or professional course ... where long periods are spent away from university or college*" (pp. 6). This is likely the sort of space envisaged by an academic participant in the review of this thesis who described the problem:

> *"The resistance type argument we get [to debates about new uses of technology and learning spaces] is interesting … and 'classrooms are best' type argument is one from some. When we poke a bit more and ask why classrooms are best, [reasons given are along the lines of] 'because it's always been done like that'. I think it is because we've kind of gotten used to it, we think it is the best ways to do learning. We only, honestly, do it that way because there's been no alternative for over 2000 years."*

Mäkitalo-Siegl et al (2010) suggest the common "frontal position" assumed by the tutor in traditional learning spaces "*creates an expectation … pupils should remain quiet and listen to their teacher, who alone has the right to talk and pose questions*". Resnick (1987; cited in Mäkitalo-Siegl et al, 2010) suggest there is a mis-match between these kind of settings and "*prevailing theories on contemporary learning*" such as Kolb's experiential or collaborative learning, using the hospital emergency room environment where decision making is distributed as an example (pp. 2).

In the light of availability of MDTs and other technologies capable of transforming learning spaces and contexts beyond recognition, it is likely debates about the issue and the traditional classroom will be another enduring one for some time yet. Calls for the flipped classroom has been creating a buzz of recent, according to Gerstein (2012). Suggestions have also included embedding technologies into everyday objects in an MDT-friendly environment. It is believed this "*makes them easy to use*" and also "*turns them into tools for effective and motivating learning*". Others include "*'scriptable classroom', where scripts and interactive furniture can be combined*" and fostering "*knowledge-building communities*" (Mäkitalo-Siegl et al, 2010, pp. 5-6; Beer, n.d.).

5.6. Pedagogy and content design for ML

If learning is to be contextual, situated and personalised etc., content design and delivery will play an important role in achieving learning objectives (Mayes & Freitas, n.d.). This may include considerations for MDTs in terms of networks and platforms; the features available on the devices, device screen size, text input system and information access functionalities. It may also include consideration for the WWW and perhaps some form of LMS or VLE. Each of these will require application of systematic design / usability principles.

Many have suggested online learning systems are becoming just as effective in achieving learning outcomes as face-to-face teaching (Sloan Consortium Online Learning Survey Report, 2004; cited in Shih, 2005). Shih (2005) theorised they can be further transformed by the affordances of wireless and mobile technology. However, while online learning may afford flexibility in a learning process, there are some challenges. Shih (2005) categorised these into two areas: motivating learners for active participation as well as facilitating and sustaining collaborative and peer learning (pp. 88). Shih (2005) believe MDTs may help resolve these issues, suggesting resolution will require traditional instructional design systems (ISD) are reviewed and modified to include specifications for connectivity and MDTs (Shih, 2005).

5.6.1. Instructional Systems Design (ISD)

Historically, ISD or Instructional Design (ID) has its basis in pedagogical and andragogical theories of learning including aspects of both behaviourism and cognitivism. Broadly speaking, the process establishes learner's ability and needs, specifies learning outcomes, and constructs strategies to support learners to achieve learning outcomes. Learning outcome can be observed, measured or assumed or not immediately apparent.

Mayes & Freitas (n.d.) theorised that e-learning is still based for the most part on traditional models of ID. This they believe is basically derived from the behavioural view point, focusing primarily on task analysis. Shih agreed with this view, suggesting that current models require modifications to include and reflect the use of MDT in the learning.

Agreeing with Mayes & Freitas (n.d.), Patsula theorised that, for online teaching to be effective, teaching and training materials will require suitable learning goals and outcome are first established. The author maintain the emphasis must be on finding a way to make the process seamless and user-friendly, without compromising on proven pedagogical principles and good practice in online content guidelines. The author cautions WWW can potentially be a major cause of wasted time as a teaching and training vehicle (Patsula, 1999).

5.7. Whose education anyway, and who decides?

Outlined in this chapter are some of the existing literature on learning theories as well as learning and teaching in adult education and HE. Adult education is predominantly dominated by experiential and scaffolded learning. Most popular learning theories such as behaviourism, humanism, cognitivism, social learning and constructivism have stood the test of time in HE over the years, adopted in varying degrees and underpinning HE learning and teaching.

However, the most important changes demanding immediate attention is the current definitions for learners' demographical profiles and learning spaces. The so-called 21st century learners are assumed to have some expectations for technology integration which may be difficult to ignore or facilitate in most of the current spaces, given the empirically supported assumption many learners own and use these technologies on a moment by moment basis. Primary and secondary data presented in the review of this thesis would suggest students enrolled in UK HEIs are increasingly MDT / technology aware and likely to expect TEL or the use of MDTs to enhance their studies.

Whether they are proficient, competent or capable of using them effectively in their learning is another matter entirely. For all that however, while an Ofcom (n.d.; cited in We Are Apps, 2013) report suggest MDTs are being used for much more than voice communication services (the latter coming last in a list of 17 items with taking photos / videos top of the list), usage in schools account for only 16%.

Usage in HE has not faired better. In general, some academics would allow the use of MDT as long as its use is not disruptive to established practices in any way, seemingly unwilling or unable to explore transformative learning uses. A total of 5 learning sessions were observed during the review of this thesis; the researcher finding similar attitudes to the use of MDT. Academics allow students to use their devices and tablets as long as it is not seen as disruptive to the session and / or based on the overall agenda / opinion held by the academic facilitator.

For example, in 1 of the 5 sessions, the academic facilitator berated a student, accusing the student of texting during the session. A brief chat afterwards however determined the student was in fact looking up one of the hand-outs pre-loaded onto the VLE. Interestingly, the student made no attempt to defend herself nor did she seem surprised by the academic's attitude. Also, while at least two of the sessions could have benefitted from MDT integration in the instructional design, it was noted none can be considered a structured ML process.

From the demographical profile presented in this chapter, ML and the structured, formalised integration of MDTs into learning and teaching at all levels within UK educational system seem an often ignored but critical component of a robust, value for money and even quality assurance provision (Beer, n.d.; Belshaw, Kukulska-Hulme, 2010; Aoun, 2014). Once, it may have been a case of 'Why ever not'. It would seem that, increasingly, it is becoming a case of ‘Can HEI afford not to’ (Kukulska-Hulme, 2010; Aoun, 2014). Consequent, theoretical understandings of learning and instructional design system models as well as learning spaces may need to change to accommodate changing contexts in education and ensure learners’ needs are adequately met.

In a keynote presentation promoting the value of flipped classroom in a big data / e-learning environment, King (2014) suggest it is not only cost effective for HEIs to encourage technology integration but also useful for customisation of learning and for collaborations with broader educational streams as relevant. A member of the audience noted the notion of flipped classrooms are being resisted currently in HEIs in Europe, to which many conference attendees agree with nodes. This was supported by only one show of hand from approximately 100 academics and learning professionals in attendance admitting flipped classroom practices, during an impromptu voting process facilitated by the speaker. A subsequent comment commented strong revolutionists will be required while the concept is being proven.

Chapter 6

Learning happens everywhere – not just in classrooms, lecture halls, and libraries, but in the hallways, in social settings, and in the walkways, courtyards … the [learning] settings of a university need to be designed with this in mind.

~ Mark Thaler, Gensler

HE stakeholders in focus

6.1. Understanding HE stakeholders

In the previous chapters a series of arguments have been presented to support the necessity for change in UK's higher educational system. These were perhaps evenly matched by suggestions Mobile Device Technologies (MDTs) may play some part in solutions for transformation evidenced from literature, primary as well as secondary data. In this chapter, analysed data and triangulations of quotations from primary sources through the review of this thesis are reported.

Vice Chancellors, Deputy and Pro Vice Chancellors, Deans and Heads of Schools and departments, IT Director and IT support staff, learning content providers, learning supporters, technologists, pre-service tutors who are themselves students, as well as students from other disciplines in HEIs were either surveyed or interviewed or both. Some were also observed to gain an understanding, not only into the perspectives and opinions of practitioners and other stakeholders in HE on concepts and issues outlined previously in this thesis, but also on events as they occur in practice. The findings are presented and discussed in empirical terms in this chapter.

A secondary equally important aim of the review of this thesis is to ascertain requirements for ML through stakeholders in HEIs, identified from both primary and secondary data sources. These are categorised and modelled in the next chapter. With the objective of aligning goals and strategic policies with these requirements, gaps between goals and practices are highlighted in illustrative models, along with proposals for bridging these gaps.

6.2. Study contexts, design plans and methods

The participants selected for the review of this thesis are members of the HE community for the most part. However, a few participants either have previous experiences or current job contracts in FE and schools (both primary and secondary), with domain-related knowledge of issues relevant to these educational levels. Also, pre-service tutors who participated in focus group studies expressed their opinions from the context of practices in secondary schools as well as their experience on their course programmes. Thus, it was possible to analyse findings comparatively to a certain extent, exploring practices across the three higher levels of UK educational system.

6.2.1. Technological innovation constraints

The challenges presented by rapid advances in technology to educational process have been discussed at some length in previous chapters. This phenomenon also affected the research design and direction, necessitating phased investigation. For example, the longitudinal studies may have provided much richer data if conducted over a longer period, but the data may have been skewed by the relatively rapid progression in device types and features as shown in Appendix 17.

Any variations in device types, features and the educational system itself will invariably affect question designs. Innovations may eliminate an issue being investigated while creating new parameters to be investigated. Definitions and what may be understood as a mobile device technology, and perhaps ML concept as a whole may shift, also affecting the review of this thesis and question design. There may also be different perspectives and responses as a result and changes in preferences, opinions as well as requirements for ML.

While RE process is sometimes able to respond to those changes through regular review and elicitation, guiding questions and principles need to be reviewed in line with changes in contexts to maintain relevance. At the same time, the scope of the research require some period of stability. Consequently, the studies of the review of this thesis were designed and conducted from this view point.

6.2.2. Designs and methods

Comparison of opinions, perceptions of the concept and issues as well as requirements for ML was a common theme running through the studies. This was accomplished on two levels: among stakeholders and between subject disciplines. The first was a survey designed to determine similarities and differences between the perceptions of practitioners and students about preferences for learning as well as factors and issues relevant to the domain. This was followed by qualitative interviews with selected stakeholders among academics in HEIs.

A longitudinal study was conducted over the period of one academic year among new entrants to university education and pre-service teachers on secondary PGCE programmes in Modern Languages and Computing. Shadow and observational studies were also conducted on selected sections of modules within Psychology, Arts and Digital Industries, Computing and Engineering, Education and the Social Sciences disciplines. Observatory notes on practices of colleagues and other stakeholders in HEIs as well as proceedings of departmental meetings, events and conferences also contributed to the data gathered.

In Chapter 3, more details are provided about the research methodology and data analysis techniques employed as well as the research questions providing guiding parameters for the review of this thesis. Issues relating to participant's consent and protection / inclusion of personal identifying data as well as validity, trustworthiness and integrity of the research process were also discussed.

6.3. Study findings and results

Specific methods and findings of studies conducted for the review of this thesis are described in the following sections.

6.3.1. Stakeholder comparison survey

Comparative study was conducted among stakeholders in HE who are in the role of learning support and governance, academics and students. Responses among participants group were compared and some formed the foundational basis from which further in-depth strands of enquiry could be launched. The object of the survey was to (a) determine if issues identified in literature are still relevant and (b) identify differences and similarities in understandings with relations to the domain of study. A snapshot of the findings are presented in this section. Full details of questions and results can be found in Appendix 5 and 19 respectively.

Method

The survey was conducted online, made available in LimeSurvey, an open source survey application, and in print. Using similarly phrased questions adapted as necessary for comparison, some were only asked from relevant sub-groups. For example, some questions related to teaching and learning are only applicable to academics and students. Data from questionnaire completed by hand were manually added to the online data. Questions are categorised as follows:

- **Part A:** Use of devices in learning and teaching
- **Part B:** Description of current uses in learning and teaching
- **Part C:** Drivers and barriers for use
- **Part D:** Evaluation of value added
- **Part E:** Content and learning delivery

Participation was encouraged through a series of emails to institutions, ML / education related lists / groups such as JISC e-learning list serves and mobile learning group on Google. Tweets about the survey were also posted at intervals on Twitter using relevant hashtags such as *#mlearn*, *#mlearning*, *#mobilelearning*, *#mobiledevice*, *#HElearning* etc. Some of the early interview participants came from these efforts.

Results and analysis

In total, 92 participants completed the surveys: 42 academics, 39 students and 11 of those in the roles of learning support & governance. The choice of which survey to complete was left to the respondents in the online system, with links and guiding instructions provided to three different online forms.

Respondents and demographical information

Approximately 73.73% of academic respondents who completed the survey were from HE while 66.67% of HE students completed the survey. Of those in the roles of learning support & governance, 59.52% were from HE while 37% failed to answer this question. No dominating discipline although students from Mathematics and Computing made the most of those surveyed (32.14%). There are more academics from Engineering and technologies (14.29%) than any other field of study.

Gender information was only sought from students and those in the roles of learning support & governance. Female respondents in the roles of learning support & governance account for 45%, while 35% of students were female. Age information was also obtained from students only and over 35% of students surveyed are under 21 years old while 21.10% are over 40 years old. Among those in the role of learning support and governance, over 45% are from the UK; 47.62% of the academics and 85.71% of students are from the UK. When asked about the types of learners taught, academics indicated 59.52% of students taught attend face to face learning sessions. Over 64% of student respondents indicated they attend face to face learning sessions.

Part A: Use of devices in learning and teaching

The aim of the questions in this section is to gather information about current uses of MDTs in learning from academics and students. Academics were directed to indicate their responses to these questions in terms of delivering, administering or facilitating learning only. Over 66% of students use or have used mobile devices in learning contexts while only 26.19% of academics are currently using mobile devices to facilitate learning (see Table 6.1).

Table 6.1: Use in teaching and learning (1)

Academic: Are you currently using mobile device(s) in your teaching? / Student: Are you currently using mobile device(s) in your learning?		
	Academics	Students
Yes (Yes)	26.19%	66.67%
No (No)	35.71%	28.21%
No answer	38.10%	5.13%

When asked to explain why they stopped using mobile devices in their teaching or have never used one, an academic respondent stated: "*traditional methods still exists*", and another said "*the technology I used is no longer available and I would have to start from scratch again*". Over 11% of academics admitted they stopped using mobile devices in their teaching or have never used one because there was never an opportunity to do so (see Figure 6.1).

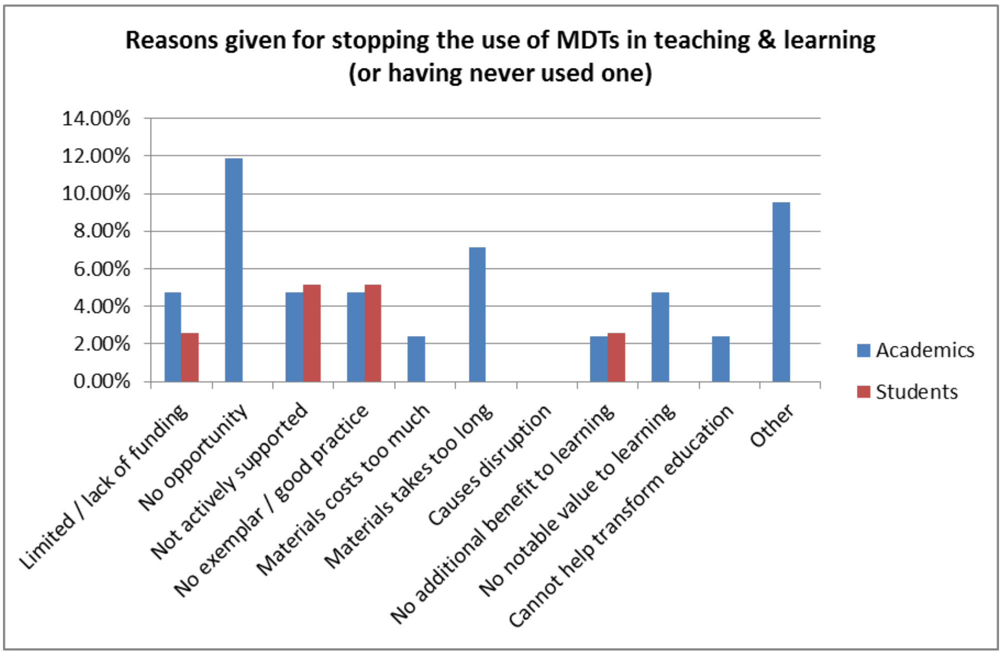


Figure 6.1: Reasons for not using MDTs in teaching and learning

<u>Part B: Description of current uses in learning and teaching</u>

For this part of the survey, mobile devices were categorised into 7 groups: Phones / smartphones, PDA, Gaming, MP3, iPad, Tablets / laptop PCs, eBooks, targeting academics and students. A decision was taken to classify iPad separately so that data can be collated on those who own an iPad. This was because it was one of the few tablets available at the time. For simplicity, uses of mobile device in learning were generically classified into five main categories as follows:

- To access web-based learning materials and online services.
- SMS messaging to interact with tutor about learning.
- SMS messaging to interact with other students / peers.
- To record information about learning for use later.
- To participate in group learning activities.

Both participating groups were directed to add other qualitative descriptions of uses. Tablets seem popular with both sub-groups for *accessing web-based learning materials and online services* (see Table 6.2). Similarly, tablets were the preferred choice for *recording information about learning for later use* and *participating in group learning activities*. Majority of student respondents (54.84%) prefer to use their mobile phones for *SMS texting to interact with other students / peers*. This may imply respondents found it more convenient to use certain devices for certain tasks.

Table 6.2: Use in teaching and learning (2)

Academic: Please indicate how you are using / have used mobile devices in your teaching? / Student: Please indicate how you are using / have used mobile devices in your learning?							
	Phones	PDA	Gaming	MP3	iPad	Tablets	eBooks
To access web-based learning materials and online services.							
Academics	20.00%	13.33%	0%	20.00%	20.00%	40.00%	6.67%
Students	35.48%	35.48%	6.45%	12.90%	19.35%	74.19%	6.45%
SMS messaging to interact with tutor about learning.							
Academics	13.33%	0%	0%	6.67%	0%	13.33%	0%
Students	19.35%	6.45%	0%	0%	3.23%	12.90%	0%
SMS messaging to interact with other students / peers.							
Academics	13.33%	6.67%	0%	6.67%	0%	13.33%	0%
Students	54.84%	25.81%	3.23%	0%	12.90%	25.81%	0%
To record information about learning for use later.							
Academics	33.33%	13.33%	0%	26.67%	0%	13.33%	0%
Students	29.03%	32.26%	0%	16.13%	16.13%	51.61%	3.23%
To participate in group learning activities.							
Academics	20.00%	6.67%	6.67%	13.33%	6.67%	13.33%	0%
Students	22.58%	12.90%	0%	6.45%	12.90%	51.61%	3.23%

Percentage values in Table 6.2 is based on the stakeholder group surveyed. Respondents are also permitted to select more than one option among the devices listed on the survey. For example, some of the 20% of academic respondents indicating they facilitate or support iPads' use to *access web-based learning materials and online services* may also have indicated they use other devices. About a 3rd (33.33%) admit they facilitate the use of mobile phones *to record information for later use*. In contrast, students seem to prefer tablets for the same purpose. This may be because academics are thinking of audio recording while students are thinking in terms of note taking or access to learning.

Additional comments for other uses seem to support this notion. Academic respondents suggested: "*Database use: many now have apps for students to use*" and "*Use phone cameras to record evidence and audio recording for* *same*". A student respondent suggested devices could be used to "*Create documents and PowerPoint*", and another student responded: "*For aging students like me I think they are fantastic. They provide ready access help in learning.*" Interestingly, gaming use, either for learning or otherwise was not common among both groups.

Part C: Drivers and barriers for use

Majority of respondents in all sub-groups seem to know someone using mobile devices in learning contexts, providing many suggesting for usage including use of QR codes to link to online help, iPad used for note taking and study groups using devices to access library resources and web searching as well as feedback. Note taking and listening to podcasts were common uses for both academics and students.

Asked to rate barriers and drivers and there seem some disparity among sub-groups (see Table 6.3). Top of the barriers' list for academic and learning support / governance respondents was "*lack of supporting technologies / software*". For student respondents, "*device battery life*" came first, followed by "*expense of suitable devices*". Learning support / governance respondents agree expense of suitable devices may be an issue but academics disagree, rating this option 7th in rankings (see Part C, Q6 in the Appendix 19).

Table 6.3: Comparison of perceptions of top barriers for MDT use

	Learning support / governance	**Academic**	**Students**
1	Lack of supporting technologies / software	Lack of supporting technologies / software	Device battery life
2	Inadequate IT support in institution for use in learning	Teaching not designed for ML	Expense of suitable devices
3	Lack of WiFi or Bluetooth connectivity	Inadequate IT support in institution for use in learning	Limited accessibility & ongoing running cost
4	Teaching not designed for ML	Modifying existing learning materials for devices	Lack of WiFi or Bluetooth connectivity
5	Expense of suitable devices	Inadequate learning support out of sessions	Lack of supporting technologies / software

Again there are some disparity in ratings for the most beneficial drivers among sub-groups. Learning support / governance and student respondents agree "*quick access to learning content / materials for students*" should top the list but Academics rate it 2nd, choosing top billing for "*can motivate hard to reach* *students*". Academic and learning support / governance respondents agree "*timely communication with students / peers*" should come 5th but student respondents rate the item 2nd on their list (see Table 6.4).

Interestingly, "*Inadequate IT support in institution for use in learning*" was given top ranking by both academic and learning support / governance respondents while students did not seem to think this could be that much of a barrier, ranking it 13th in their list.

Part D: Evaluation of value-added

To evaluate value added to learning, respondents were given a list of statements to compare (see Part D, Q8, Q9 & Q10; Appendix 19). Both learning support / governance and student respondents believe MDT "*encourages students to seek further support when needed*" while majority of academics seem unsure (23.81% *for* and 28.57% *unsure*). All sub-groups voted for the suggestion that MDT's usage in learning "*is useful and helpful to students overall in learning*".

Table 6.4: Comparison of perceptions of top drivers for MDT use

	Learning support / governance	**Academic**	**Students**
1	Quick access to learning content / materials for students	Can motivate hard to reach students	Quick access to learning content / materials for students
2	Provide access to information in remote locations	Quick access to learning content / materials for students	Timely communication with students / peers
3	Quick access to social networking sites / email etc., for students	Provide access to information in remote locations	Can positively enhance / support learning processes
4	Enables location-based / contextual learning	Can positively enhance / support learning processes	Enables location-based / contextual learning
5	Timely communication with students / peers	Timely communication with students / peers	Can support students with special needs

Part E: Content and learning delivery

Questions in this section aim to explore provisions and perceptions on the necessities for specialised content for mobile devices and learning delivery administration. Academic and learning support / governance respondents seem to more or less agree on the support that should be provided in terms of content and learning delivery (see Table 6.5 and Figure 6.2). The question was not asked of student respondents.

Commenting further on this issue, those in the role of learning support and governance added further "research with practical experience" as well as "good quality research of ML being done without institutions trying to control device or 'encourage' our students to 'be more effective'" will be needed. A respondent added in reference to students: "Maybe if we looked at what they do we could learn from them."

Table 6.5: Mobile content support needs in order of ranking

	Learning support / governance	Academics
1	Staff development training on content delivery and ML.	Staff development training on content delivery and ML.
2	IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs).	IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs).
3	Champions and early adopters sharing good practice.	Funding support for ML projects.
4	Awareness sessions and institution-led culture change.	Awareness sessions and institution-led culture change.
5	Funding support for ML projects.	Champions and early adopters sharing good practice.
6	ML project collaborations across institutions.	ML project collaborations across institutions.

Over 52% of academic respondents said they don't make teaching materials available for mobile devices specifically. Top reason given was "*there was never an opportunity to do so*". One additional comment on this issue suggested "*students should be able to use smart phones to connect to the learning environment through the web and find everything there*", adding further "*then we need only develop things once*", suggesting the need for content reuse which has not been explored within this survey. One respondent had not considered whether there was any need for the creation of contents specifically for mobile devices.

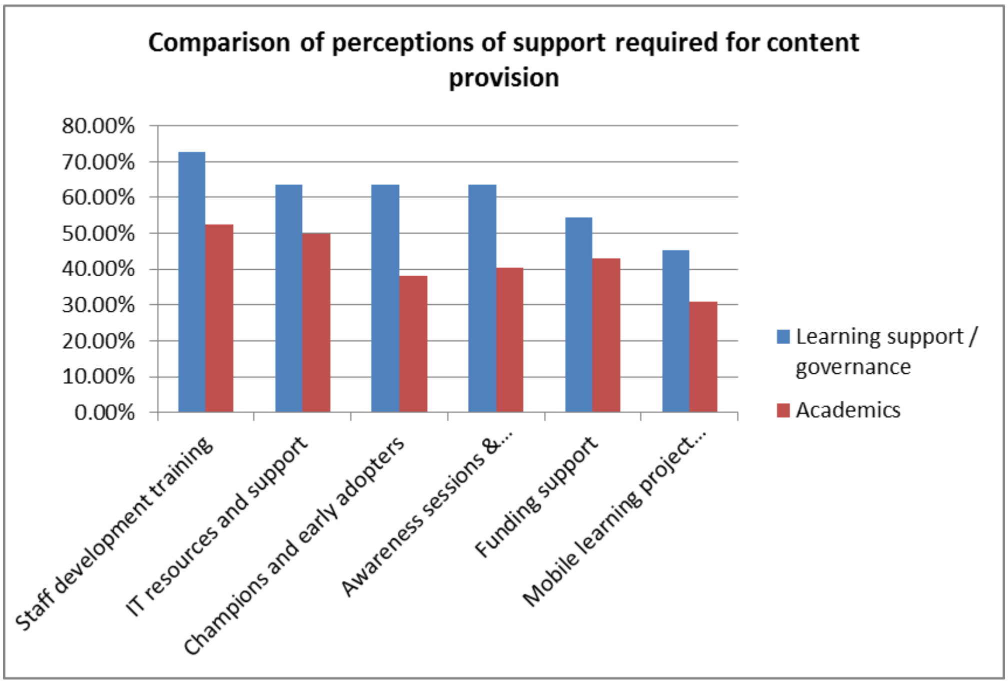


Figure 6.2: Mobile content support comparison

Students and those in the role of learning support and governance seem to agree on the necessity for mobile device optimised content (64.10% and 66.67% respectively) while only 30.95% of academic respondents saw this as a necessary option. Comments from academics will seem to indicate not much thought have been given to this issue but it would seem students expect such resources. This was explored further during interviews with academics.

<u>Additional comments / concerns</u>

An interesting comment about Apple Vs open source is perhaps worthy of note, and a good example of how much MDT contexts are subject to changes. A respondent from one of the learning support and governance stakeholder group stated:

> *"iOS is probably the worst possible thing that could EVER be brought in to educational settings. We need open standards not closed systems which are built specifically around turning students into consumers of apple data and 'needing' overpriced devices. Apple are essentially a vampire on music and education and their acolytes who promote everything as if apple are good or they are cool or edgy by owning an overpriced shiny thing should be told to unequivocally shut up and stop acting as apple marketers in educational*

settings."

A lot has changed since this comment was made but Apple devices are still proprietary. Also, there are now other competing streams e.g. online learning platforms such as MOOCs (Massive Open Online Courses) and several other open source learning application / platforms as well as BYOD schemes. Other tablet device brands have also been launched in the marketplace. While it was impossible to follow up on this respondent, relevant issues within this comment was further explored during interviews.

Academic respondents raised concerns about the general lack of on-going support institutionally for ML projects; one suggesting "*benefits must surpass costs for both students and institutions*" to be sustainable. One academic also commented that "*not all students are young technically savvy*". Interestingly however, one of the respondents believe "*there should be new learning methods adapted to these new technologies*", seeming to agree with the views proposed in literature (Belshaw, 2010; Traxler, 2012).

Students' comments seem to reveal due considerations have been given to the distractive aspects of the use of devices in learning. One commented:

> *"Great idea to use mobile devices in learning; however one has to tread carefully since they can be quite a distraction in class. It really depends on the user and how seriously they would use their mobile for learning among other social activities."*

Several others mentioned the likely tendency of mobile devices to act as distractions in learning while supporting their use. Others are not too enamoured by ML specifically, one stated:

> *"It's a waste of time and resources investing into this, why use a mobile device when you can just as easily learn it from a computer. But this opinion could just be because I study a Computing course in which being at a computer is usually an advantage when studying."*

The above comment was seen as a likely indication of discipline-related dimension explored further in the design of the focus group studies. It may also give credence to the notion not all students are necessarily able to use devices effectively in learning.

6.3.2. Qualitative interviews

Qualitative interviews, conducted within the last 14 months of the research, were designed to obtain opinions and perceptions on current issues within the domain. Interview participants include those in governance and university board levels, academics who are ML enthusiasts and known educational theorists in their fields of operations, learning technologists / content designers and developers, and IT support personnel. There were some interviews conducted informally during observations and notes taken on responses; discussed later in this chapter.

Grouping of participants generally determine the phrasing and type of questions asked. For example, some participants grouped into governance or learning support categories carry out some academic duties and vice versa. Two of the academic participants also work as curriculum / academic developers. Participants are considered belonging to a grouping if performing relevant duties for more than 75% of their time. In cases where there are cross responsibilities, opinions were also sought in relation to secondary duties.

Depending on the stakeholder grouping, interview questions were guided by the following general tracks / topics:

- Understanding of ML
- Participants' ML experience and activities
- Impact of progression / innovation in MDTs on teaching and learning, student demographics, curriculum etc.
- Discussions on ML content / materials availability and requirements
- Perception of HEI's approach to MDT integration
- Predictions / recommendations for the future

Identifying information have been omitted from quotations and alphabetic letters used instead to identify participants.

Participant demographics

In total, there were 21 participants from 6 HEIs; 3 of them pre-1992. Apart from role categorisation, it was necessary to further categorise interviewed participants according to their preference for or activities relating to ML, so their contributions can be viewed from this perspective. Therefore, all interview participants are further grouped into *ML expert*, *ML novice*, *ML inactive* and *ML sceptic*. See Table 6.6 for the breakdown of participants and their grouping.

Table 6.6: Participants categorisation / educational experience

Participant	Category	Years in HE	Years in other educational sector (if known)
Academic A	ML expert	16	
Academic B	ML expert	13	
Academic C	ML expert	5	14
Academic D	ML expert	4	
Academic E	ML expert	8	
Educational expert F	ML novice	10	
Academic / Developer G	ML novice	17	
Educational expert H	ML novice	11	10
Academic / Developer I	ML novice	5	*14
Educational expert J	ML inactive	4	18
Educational expert K	ML novice	18	*11
Governance L	ML inactive	40	6
Governance M	ML novice	24	
Governance N	ML novice	3	
Content developer O	ML novice	14	
IT support / Governance P	ML novice	3	15
Learning technologist Q	ML inactive	1	4
Educational expert R	ML novice	7	19
Governance S	ML expert	8	
Governance (IT) T	ML novice	2	
Learning technologist U	ML expert	8	
		221	111

** Includes experience at Primary level educational sector*

Participants are considered *ML expert* if they have actively supported ML, perhaps through publications or participated in two or more activities / projects involving the use of MDTs and / or facilitation of at least two ML sessions with cohort(s) of learners. Participants are categorised as *ML novice* if they have participated or experienced the use of MDT in learning but are not the initiator or facilitator. *ML inactive* are those who may have been ML experts or ML novices but have been inactive within the domain for over five years.

Participants are categorised *ML sceptic* if they expressed disinterest or opinions against the use of ML or MDTs in learning. It was difficult to find anyone fitting the latter category because to some extent, all participants seem to believe there are some potential benefits for learning use of MDTs.

As shown in Table 6.6, interviewed participants have a total of 221 years' experience in HE and 332 years in various parts of the educational sector altogether. All participants have worked in higher educational environment for several years, over ten years in many cases. Two of those in Governance have only worked in HE for two and three years respectively, having worked in applications development and financial industries prior. The two have the least experience of all participants in educational sector. A member of the learning support participants have also worked as a tutor in FE for four years. One of the participants actively support devices day to day in BYOD scheme.

Only seven in total among all interviewed participants have facilitated the use of MDT in their teaching practice. Three facilitated the use of MDTs in sessions but admit they are no longer involved in any ML or MDT activities. Two of the participants have worked in all three of UK's educational levels: Schools, FE and HE; one possessing seven years' experience of HE teaching, but nineteen years' working in other educational sectors. The second participant have only four years' experience in HE but over eighteen in FE and Schools.

Understanding of ML

Given the tendency for those active in the domain to define ML in so many different ways, the objective was more about gaining some perspectives on people's opinion of how ML is understood or should be perceived as a concept. Therefore, questions relating to this track were deliberately phrased to determine understanding of ML as well as any definition that may be proposed or preferred.

The general concern seem to be more about making sure learning was prioritised; supporting the common criticism technologies are sometimes integrated into teaching practices without adequate consideration for pedagogy:

Academic D (ML expert):

> *"I would expand [on current definitions] to say ML must also be seen in the context of blended learning, where it is just one tool used with other technologies and the emphasis must be on the learning that takes placed; whether formal or informal. There must be evidence that learning has taken place."*

Academic D added preference for definitions such as Traxler (2007)'s. the participant added this definition was preferred because mobility of the learning and learners are prioritised, suggesting they are key differentiators between an ML and an e-learning process. Another academic supported this view:

Academic E (ML expert):

> *"The problem I have with definitions of ML is that historically, they tend to focus on the mobility of devices, without addressing the mobility of learning; and haven't necessarily address the mobility of learners …"*

This comment hinted at a time-related pattern in definitions, or likely tendency for definitions to sometimes reflect advances / limitations in MDT development. Another academic described this phenomenon.

Academic B (ML expert):

> *"I can understand why we started off with these techno centric definitions in terms of technology, hardware … and I can understand how, partly, that could be quite problematic because it means you are always looking backwards. And there is always a risk you'll ignore the education dimension. So I can understand definitions now in terms of the learner mobility as being more robust and intelligent and of more interest to education … which is basically the business we are in."*

Academic A also commented on some of the difficulties with earlier devices and how this might have affected practices at the time:

Academic A (ML expert):

> *"The context was more of personal organisers, old-style mobile devices e.g. Nokia 8191 or something like that … and hardly none of the students have those. It was all about projects that had to provide the technology to learners rather than learners bringing their own devices."*

Academic A added, suggesting ML is primarily driven by MDT availability and the affordances they provide to education as well as how this might support learner development.

Academic A (ML expert):

> *"So, what we are saying is we have a 'resource ecology' available to us human beings in the world which includes technology e.g. mobile devices. How can we utilise the affordances of these devices – what are the affordances and how can we utilise them in order to lead more fulfilled, more successful, more effective ... whatever – lives?"*

One of the participants admitted studying a module on ML in HE which influenced practices later:

Learning Technologist Q (ML inactive):

> *"When I did my Master's degree … there was a whole unit / module [on ML] … [My lecturer] … sort of gave us a definition about ML being about mobile devices and also learning on the move and being able to learn wherever you are and it doesn't actually have to be about a mobile device ... So I had a good understanding of ML."*

Asked if worried about the disparity between definitions and how many of them there are, many seem unconcerned:

Learning Technologist Q (ML inactive):

> *"Well, I think the context could be quite transient but I am not really aware of the disparity in definitions myself; I haven't really looked at that aspect. I think as long as there are elements of good learning going on and learning objectives achieved than it probably doesn't matter."*

An academic agreed, suggesting this may in fact be an advantage:

Academic E (ML expert):

> *"I kind of like the idea that ML definition can continue to be subject to proof of concept … and continue to evolve … because it may follow the logic that technology keep evolving, shifting the goalpost almost …"*

A view also supported by another academic:

Academic B (ML expert):

> *"I think that should make things easier because everyone can kind of make the learning fit their own particular context. I noticed over the last 5 years, the impact of research becoming less and less because everyone has a mobile phone so they think they understand what it is all about. I think you may get hung up on thinking having a standard definition is important but a lot of the time it just says what you believe about the concept."*

Thus, it would seem many are coming round to the recognition, seeking a consensus on definition may be a waste of valuable time. An ML novice member of the governing board offered a description for ML which may indicate those considered novice or inactive are perhaps not concerned or confused about what ML is in general:

Governance N (ML novice):

> *"The word that stands out in the phrase [ML] is the word mobile. Mobile doesn't suggest 'a great distance' nor does it suggest 'remote'. It is about being 'on the move'. So to me, ML is about learning while you are on the move … which suggests it is integrated learning while engaged in another activity, whatever that may be. It kind of suggests there is a form of technology as enabler."*

There is therefore a general acceptance ML can be given room to continue to evolve and innovate; transforming learning as the affordances offered by MDTs are further developed, along with a preference for an ML process which takes advantage of the "mobility" affordance.

Participants' ML experience and activities

Questions in this track explored participants' activities and experiences in relation to ML or the use of MDTs in learning and teaching, either as a facilitator of learning or as a learner. Opinions on current practices were also sought to gauge perceptions on issues which may be related to the lack of consensus in definition or conceptual understanding or both. A former FE tutor who became a Learning Technologist in HE reminisced:

Learning Technologist Q (ML inactive):

> *"I worked in an FE college and there was a funding made available through the Mobile Learning Network formerly known as MoLeNET. They resourced countless of colleges all around the country doing projects, and because it was early stages, there was a lot of kind of questioning about the value of using mobile devices for learning … At the time, I think I was just keen to get some mobile devices into the college I worked in, just to kind of show the worth of it."*

The implication in this statement that there was no initial planning or consideration beyond obtaining the funding for trials seem typical of trends as MDTs emerge in the early 2000s. An academic participant also recalled there were lots of funding available which on reflection was probably not allocated in the most effective manner.

Educational expert J (ML inactive):

> *"I don't think we necessarily considered properly where the money could be put to good use. We needed clearer cut suggestions for where it could be used more effectively and that seem to have been missing in many ways, although a lot of good was done."*

Progression and innovations in MDTs have also influenced practices and research approaches. For example, there were some difficulties noted by trail-blazers and early adopters in those early practices. An academic explained some of the problems:

Academic A (ML expert):

> *"What we decided to do is we decided to do some conceptual and theoretical work first; develop models. And subsequently, we went out trying to validate our hypothesis, our concepts, our theoretical understandings through practical work in different concepts. So we worked with students – pharmaceutical students, universities etc …"*

Academic A, who was also involved in the MOBIlearn project went on to describe an early ML implementation:

Academic A (ML expert):

> *"Here in London, we looked in particular at ways of using mobile devices to support the reintegration of young people who were at a distance to schools and to formal education, been excluded and have left school or something like that, wanting to re-engage …"*

As funding streams stopped, there was a need to change the focus. An academic viewed this development as a positive step for the future of technological integration:

Educational expert J (ML inactive):

> *"Now the money's dried up, we've had nothing and there's hardly anything going on now. And it's not about anything that fantastic, it's about opening people up to what they could do with technology in a lot more dedicated ways."*

Learning Technologist Q, categorised as *ML inactive* but was involved in the MoLeNET initiative agreed:

Learning Technologist Q (ML inactive):

> *"I agree there was a lot of money wasted particularly on capital and infrastructure; there was a lot of money thrown at that … At the beginning, I think they had to use the MoLeNET funding to get that infrastructure in place ... You sort of needed that WiFi in place for the projects to work and MoLeNET funded a lot of colleges to be able to get to that point. So that's really got to be a good thing I think in the long run and probably the benefits of that are being realised now."*

This change in focus has also affected the types of ML related activities undertaken:

Academic A (ML expert):

> *"What is very important for us [now] is an analysis of the transformations that are currently taking place in the world around us; be they culturally, be they at a societal level, be they economically, be they educationally, be they technologically ... and what we are arguing is that you have to see and understand ML in the context of a world in transformation."*

In contrast with the almost frenetic activities in the early 2000s therefore, participants admit ML initiatives have stalled or are non-existence in the HEIs they belong to. An academic suggested one likely reason for this:

Academic B (ML expert):

> *"If you go along with the argument that it is the responsibility of university or the school system to provide technology. Then all of a sudden, you find that you are in an unsustainable position because it is an expensive technology to supply … and universities can just supply computers and that's it these days. So the technology economy around education is troubled and the digital technology changes very fast and platform implementations are higher and diverse. The university's capacity to supply diverse and up-to-date technology is very poor."*

Some suggest BYOD schemes and MOOCs may now be part of the solution; the former resolving device availability issue for students and the latter, content availability. An academic saw the MOOC idea a potential opportunity yet untapped:

Academic C (ML expert):

> *"I am not convinced that MOOCs as they stand at the moment will carry on the way they are at the moment. What I do think is, if you look at universities getting together as a league … a league of universities getting together to create powerful far reaching electronic platforms of contents that can made accessible to students everywhere ..."*

Another academic offer several suggestions on the way forward for BYOD schemes:

Academic A (ML expert):

> *"I think the main challenge is at the infrastructural level to make it possible for users to bring their own devices [in a BYOD scheme] and to use them effectively from the technical perspective. And secondly to work with colleagues to ensure that they understand the potential of having a group of students that have multi-functional devices and how they could be integrated effectively into the learning."*

However, some are concerned BYOD support provision may not be well thought out and getting it to work may be distraction:

Academic C (ML expert):

> *"I think at the moment, we are distracted by the practicality of doing this [getting our BYOD scheme to work] or whether or not we can do it that there's not a lot of discussion going on about why we would want to do it."*

A few others agree, adding BYOD support alone cannot resolve problems with MDT integration:

Academic / Developer I (ML novice):

> *"It should be embraced, but you can't and shouldn't allow Bring Your Own Device [BYOD] to be the only effective way for those opportunities."*

On the issue of MOOCs, many welcome this development in general but some are concerned their impact on HE may be under-estimated, supporting a view proposed in IPPR report (2013). A participant wondered:

IT support P (ML novice):

> *"The development of MOOCs offering free courses online – that's pretty radical. How does other institutions deal with that and how will it affect the bottom line? So, I think that's one example of education changing the game."*

As an ML implementation review by Frohberg et al (2009) found, the legacy of both MoLeNET and MOBIlearn, two of the most extensive initiatives with perhaps the most impact in the last decade continue to be felt one way or another.

Impact of progression of education and / or innovation in MDTs

Questions in this track were designed to determine noticeable changes in practices and the likely impact of, or the part played by MDTs as well as perceptions of MDT's location in educational practices. Participants were asked questions on progressions over the course of their career in education in relation to technology, students, educational theories and instructional designs. Impact of particular events, policies or reforms on education and technology integration in learning and teaching was also of interest as are opinions and philosophical understanding of educational theories and adult learning.

Asked if they thought there have been any marked difference in education as well as learning and teaching during the course of their career in education. An academic with over 39 years' experience in educational sector responded:

Educational expert K (ML novice):

> *"When I trained, the theories I came across and that I've always worked with, and which is dominant is social constructivism by Vygotsky. Piaget was bigger than he is now but social constructivism is still the dominant theory and that hasn't changed, but this government don't like it. So, there is a strong imposition of non-theoretical ideas really. So rather than a progression on theories, it is a progression towards no theories."*

The same academic explained further:

Educational expert K (ML novice):

> *"I think we've gone backwards … bearing in mind my main teaching experience is in primary schools. When I came to the university, I brought with me my understanding of learning and teaching. I also teach a programme which is for lecturers teaching across different universities and know there are very different ideas about learning and teaching in HE, some of which to me are very old-fashioned … I don't see they have progressed forward at all."*

Another academic who is also an educational expert agreed there is a backward trend in teaching and learning, especially where technological integration is concerned:

Educational expert F (ML novice):

> *"My impression is that educational theories are in a static flux. I don't know how joined up learning theories are with technological integrations and pedagogic use. For instance, learning theories and online learning theories seem to be going in different directions, and this is just my impression. For instance, I have an issue about whether connectivism is actually a new learning theory. I also, to some extent believe … and this is what I was saying about running an entirely online [distance] module, that the process seem to lend itself to constructivism more … almost going backwards in time."*

Another educational expert agreed on the backward trend, suggesting introduction of some technologies (e.g. PowerPoint presentations) may in fact have led to some of the deterioration noticed in teaching quality:

Educational expert H (ML novice):

> *"I think it [PowerPoint presentations] sets us initially 25 years backward in the past. Just when we just started to get teachers in groups and get experiential learning going, it took them back to the front of the classroom again and then we spent the past 10 years trying to change that."*

One academic developer noted some positive impacts brought about by technology, especially given massification of education and the introduction of tuition fees (in his opinion):

Academic / Developer I (ML novice):

> *"I think there's awareness of the role and importance of learning and teaching unlike ever before, to a certain extent, as the consequences of mass education and student fees … but there is an awareness of learning and teaching and having a priority and significance as perhaps it didn't have in the minds of HE lecturers 10/15 years ago."*

As future trainers of future tutors, academics on the PGCE programmes seem to have noticed some changes more related to curriculum in the schools pre-service tutors will have to practice in. An academic on the secondary PGCE (Computing) describe recent changes to ICT curriculum in schools, explaining the rationale behind the changes:

Educational expert J (ML inactive):

> *"The biggest change is, ICT's been up in the air for the last 2 years. Well, the problem's come to light in the last 2 years, but I'll say in the last 5 years there's been questions over the ICT curriculum because a lot of people haven't felt it did the job and to a great extent, I would agree with that. ICT had become about application based skills, very digital literacy based realistically, and very repetitive although not everywhere."*

The academic added pre-service tutor students may have problems coping with these changes. Another academic noticed increased used of online technologies as repositories for learning content on the PGCE programmes may have some negative impact:

Educational expert F (ML novice):

> *"Students may have problems using the technologies effectively to access resources or making sense of them … I think some of the problem is due to the fact that there is a gap between people who did undergraduate courses and trained for PGCE several years ago when there wasn't such an emphasis on online courses and the use of technologies in learning is still very little or not at all. Whereas, now when they come onto PGCE, there is much more engagement with online technologies."*

When asked if there are differences in students' behaviour and expectations with regards to learning and teaching, a participant responded; with the caveat the response may have been influenced by a relatively shorter length of service in HE (previously in the financial sector):

Governance N (ML novice):

> *"You have to put everything I say in the context of the fact that I've only been in the educational sector for three years … But I can look over the last two and half years and I don't see much change in student behaviour. The negative*

things I see which I find disappointing is the right-driven culture, the right to learn. I see a culture where more and more things need to be served to people rather having them going out and getting them. I see a lack of engagement."

Another member of the university senior management team agreed about the lack of noticeable change in student behaviour:

Governance S (ML novice):

"Generally, I don't actually [see any change in student behaviour]. I've been in education for 20/25 odd years … There are more international students than before but not a lot more, because there's always been international students in UK universities. No, I can't really see a difference; their expectations appear to be the same, abilities about the same."

These comments seem to suggest students themselves are still the same in terms of behaviour, aspirations and abilities etc. When pressed further about students' behaviour in terms of ready availability of innovative technology, a faculty dean described the impact of technology on a discipline:

Governance N (ML novice):

"I think there are two different things that I can think of relating to teaching and learning; if you think about … what we teach students … about technology, gaming, video, film etc. So there's the subject area aspect and in that sense, it hasn't really changed. Not in terms of tools but the speed with which students can create content has changed. In my days, we use video tapes, now it's all computers … But also now there are terabytes of storage space available for content and you can take a large amount of stuff around with you wherever you go …"

Next, questions were asked relating to the impact of progressions in MDT and ML. One of the criticisms levied against existing ML implementations concerns the use of MDT as content delivery tool (Liu et al, 2007; cited in Brown, 2010; Valcke, 2011). An academic agreed it was a problem, suggesting this may be in the past and the phenomenon may not be limited to MDT only. There was also a suggestion this could have contributed to the downward trend described earlier in teaching and learning quality:

Educational expert F (ML novice):

> *"I think I would add that it seemed to me that in the beginning, it was used more as a way of getting materials to students without any real thought about the learning and how that might be achieved through the technology ... I don't think we [HE tutors] are alone in that more of the uses of technology tend to be about delivery of content or accessibility primarily and an example is the thinking behind the MOOCs … and now there is this general thinking by the universities now that we've just got to put everything online."*

An academic with several years' experiences of facilitating learning with MDT and publications on the subject gave an opinion:

Academic E (ML expert):

> *"I don't really think it matters. It is important to just focus on what's happening with the device rather than to try and make it something extra special. If delivery to a device is a bad thing, what happens if you've got a doctor about to perform a procedure or better still, someone wants to administer a drug and they check what's the right amount to give ... right there and then, they pull out their device or tablet and just check. That's delivery of information but really important."*

Challenges posed by rapid innovation in MDTs was another issue explored. An academic, who is also a learning developer gave an anecdotal response:

Academic / Developer G (ML novice):

> *"I went to an event run by a group of academic developers – a national group – and it seems to me a lot of people who are attending are in the same sort of situation. They see that technology is rapidly changing and things are moving rapidly, and they feel like they have to try very hard to keep up. They feel a little bit unsure about their skills, they are insecure in their knowledge … and they feel they need to know more. But they are not quite there … They are confident in their practice in terms of teaching and learning but they are not confident about how to integrate technology. There's a sense that there's just so much … Where do you start? What do you engage with?"*

This revealing comment summed up the general feeling among academic participants regarding the sheer number of options available in terms of innovative technologies and lack of confidence in their use. Among those interviewed, 7 admit they feel overwhelmed and the reaction is also not just limited to those that may be considered novices on technological use.

For example, the participant making this comment is an academic developer who, although classified as 'ML novice', is not exactly a novice in terms of using technology in general as he explained during the interview: "*I wouldn't say I'm a technophobe. I've adapted to using technology in my teaching over the years*". He confirms this notion:

Academic / Developer G (ML novice):

> *"This is especially true for an academic developer. You are working across different [subject] areas and the technologies they want to use in areas like Fashion Design is going to be quite different from what Engineering would use and so on. How is it possible to cope with the pace of advancement and all the options?"*

However, he added the feeling may not be unrelated to the nature of his role, but suggesting it could be more of a problem for those without / with limited expertise. When pressed further on how the issue may be addressed, suggestions include setting priorities based on what's required to achieve learning objectives, and / or what the students need, and perhaps getting started on that. One academic responding to questions relating to the issue identified another potential problem:

Educational expert H (ML novice):

> *"There are some great stuffs out there I should be engaging with; I mean, what I've got on my mobile phone now will be unimaginable 5 years ago. But again, it comes down to the fact that the stuff you want to do is limited by the infrastructure you are surrounded with and the technologies that exists in institutions like these. I mean, our computer system limits what you can do in collaborative connections."*

So, while infrastructure provision has improved tremendously, there are some evidence a lot is still needed and a member of the senior management team acknowledge this:

Governance M (ML novice):

> *"Another thing is we've got to think about is making our infrastructure more robust. I don't know about you, but one thing that get me frustrated is when I can't access my files from home. I had to use the Dropbox sometimes but that's limited ... Academics are using Facebook as part of the curriculum almost. And they're using that as a communication tool with their students. They are using it because (a) it is easy for them to use (b) they know it is a 24/7 trusted and robust environment and students are likely to be there and (c) we don't have an easy-to-use learning environment that can be compared to that. So they're using other platforms to achieve what they want."*

The idea of a 24/7 learning platform backed by a robust, fast and seamless network and connectivity was mentioned quite a few times among participants. Many in governance roles see this as an essential strategy for attracting new students: "*If we want to be known as an innovative university and attract the best students, we need to build an environment that will enhance their learning*", stated Governance M, an ML novice and a member of the senior management team. Governance N who is also an ML novice agrees, stating students require "*a 24/7 access to learning; an easy environment where [students] can be free to create and also socialise*".

Government reforms and policies was another important change with potential impact. Many are unsure the changes are necessarily producing the right results. Asked if UK government reforms could transform practices, an academic seem uncertain:

Academic C (ML expert):

> *"The UK government is driven by market trends at the moment and I don't think they are going to change anything. And I'm not convinced it will work even if they did anyway. I think it is very hard."*

Another academic seem to agree, stating:

Educational expert H (ML novice):

"It is a tricky question because HE covers a huge area and I can't comment on other disciplines. If we look at it from education discipline perspective, we are at a critical point in teacher education. The coalition government have been in for 2 years, and at the moment as we speak, is carrying out an ideological attack on the role that universities play in teacher education. The education minister at the moment is trying to force teachers out of universities into schools."

The rate at which the reforms are being implemented was also of some considerable concern. An educational expert explained:

Educational expert R (ML novice):

"I am not against change, change is a good thing. But there are too many initiatives all at once and this is preventing us and our trainee teachers from really working through anything. There's a new this, new that … and there's really no evaluation being done, they never seem to let anything run long enough to see whether it is working before another new thing is introduced."

Participants were also asked to comment on progress in the educational system and its fitness for purpose. An educational expert described his experience when working with A-level students:

Educational expert J (ML inactive):

"Somewhere along the line I think too many children are losing that joy of learning that we should try to nurture, they're just not bothered. They're switched off for lots of reasons, lots of debates we can go into. One of the things when I was teaching [in schools] is I felt I had become a 'statifier'; I was very conscious of what I refer to as 'stats'. I felt I had become – I was a leader of subject, I was leading more than one; two or three subjects at the time – and I felt I had become a statifier; just satisfying exam results, getting great exam results."

The participant who is also considered an educational theorist added:

Educational expert J (ML inactive):

"They got great exam results, they loved it and so did their parents. But I

wasn't sure it's what we should have been doing; their success really didn't stack up. It was convenient, being successful. We know what A looks like, we know that child can get an A [and that seem to be all we care about]. So, we line that up. We know what Cs and Ds look like … and it becomes far too driven in one particular direction that I felt very uncomfortable with."

This idea that teaching and learning has become perhaps too 'procedural' was also expressed by another academic:

Educational expert H (ML novice):

> *"The education industry is at the moment turning over somewhere in the region of £38/39 billion; that's more than our automotive industry. We are setting up institutions, targeting overseas students so that we can bring them in; and sometimes we are providing courses that are sellable rather than those encouraging those challenging questions I mentioned earlier and just issue certificates at the end of it."*

The "*challenging questions*" referred to in this comment relate to the participant's desired expectations for students, suggesting they need to be encouraged to practice 'deeper' levels of inquiry and "*challenge and question at every level what they have, up until that moment, perceived as … the truth*". The comment also highlighted the dilemma between consumerism and maintaining ideals and rigour in educational processes. Identifying another problem relating to the level of academic engagement, the academic added:

Educational expert H (ML novice):

> *"When you are pushing academic staffs and universities produce academic staffs like that, and then naturally separating them based on their performance in one area, it creates silos like we have here. We have some of the best academics in the country but they never engage with undergraduates. Why? Because their job is to produce 4-star / 3-star journal papers. We are not actually allowing our students to benefit from the talents we have in-house, no knowledge transfer in that sense."*

The issues explored in this section are by no means exhaustive. In summary, these concerns include the perceived backward progression in teaching and learning quality, sudden changes in the curriculum without adequate time to review and evaluate before new educational policies come through, changes (or lack) in student demographics and HEI's response, challenges imposed by rapid innovations in MDT, level of infrastructure and connectivity provision, government reforms and educational progression etc.

Other issues worthy of note relating to changes and trends include the hype usually accompanying innovative technologies such as MDTs and MDT apps. At least 3 academics suggest hyped activities without due considerations are sometimes unhelpful; one mentioning learning apps in particular. While some learning apps are considered useful, the concern about lack of standardised approach to topics / subjects relating to core learning programmes was mentioned.

ML content / materials

Discussions on availability and requirements for content / materials was also impacted by rapid changes in technological development as well as the wide range of devices, platforms and content access technologies to design for. A content developer revealed:

Content Developer O (ML novice)

> *"Our website for instance is not only designed for users in the UK but also for international audiences. Therefore, even though some of the most sophisticated devices are being used by users in developed countries; international users may have problems with bandwidth and connection, having to wait a long time for downloaded content. A wrong choice could impact several potential customers … The same goes for learning content uploaded to our VLE website."*

As far as academics go, when asked questions on the subject, one responded:

Educational expert F (ML novice):

> *"I think … it is about what platforms to design learning for e.g. say everyone is using iPads or the same smartphones … then everything can be designed really well and problems can be anticipated. It will also be easier for learning devices using the same platform as everyone else and addressing the issues.*

… Whereas if you have to design learning for different devices on different platforms, my sense is it may be difficult to get the same effectiveness. It may be limited to just adapting existing materials and using short tasks without really providing activities leading to 'deep learning'."

This comment highlighted problems arising from developing learning content for variations of devices as well as network platforms. On that issue however, an academic developer did not see the problem:

Academic / Developer G (ML novice):

> *"I would just have to say: 'You [to the student] tell me how that [a learning activity] works on your device and is there a way that we need to present the materials and the way that we run these sessions that will allow you to get motivated to use your device more effectively in your learning?' … It is more about the way I am making my materials accessible and the way I am running the session ... 'Is that helping you or do you have some issues with that?' … [directed at a hypothetical student]."*

Content Developer O agreed developing for different devices / platforms may increasingly become less of a problem with time, explaining:

Content Developer O (ML novice)

> *"BYOD is going to be tricky but in fact, networked [legacy] computers are more challenging because the fact is most of the devices used to access our networks have the latest build and versions of the operating systems and browsers installed but our network is still using some of the older versions and are locked down to this for many years … unable to handle the latest responsive technologies for cross-platform content provision."*

The latter also suggested rapid changes in technology may not be such a problem as manufacturers give advance notification of releases to consumers and users in general, allowing them to test these systems before full launch. Another participant suggest the problem may be many organisations are not taking advantage of the opportunities offered by these early targeted release schemes, mentioning educational communities in particular, to implement a thorough testing period for new releases on a regular basis, and in line with their network provision.

Both academic developer participants agree with the content developer, also referencing the common practice of application developers to release Beta, Gamma etc., versions of applications to the general public first before live versions. This they believe are ploys to ensure consumers have time to become accustomed to changes in technologies, adding content developers in education should make a habit of getting involved in version testing schemes.

Perception of HEI's approach to MDT integration

Questions in this track sought opinions on own HEI’s approach to integration of MDT. Participants were asked to rate progress / efforts in own institutions and other learning establishments they may be associated with. They were also asked to rate progress in general in other educational levels in the UK depending on their experience. Finally, participants were invited to suggest how situations could be dealt with differently to address any issues identified / suggested.

Two of the participants wanted assurances part of the comments made will not be identifiable with their institutions; and both were assured of this. This feeling seem to be shared, although not specifically expressed, by three others. As a consequence, responses in this section will be provided in a general sense to avoid revealing the identity of the institutions referenced. This was not considered a problem for the review of this thesis because several of the responses relating to changes and progressions imposing challenges on educational system, considered previously, may also be relevant as an assessment of HEI’s approach. All the responses may perhaps be summed up in the following comment from a participant:

Academic E (ML expert):

> *“We are not doing so great. … I think there are several things an HEI can do that will enable better use of mobile devices. One of these is making the network structure simple, so that everyone who works through the door can pick up a wireless signal … There’s an issue of risk, security and tolerance*

around how open we make these networks. Where the legal compliance and the requirement to keep services running that IT services face is at odds with pedagogic design; it limits what's possible …"

Another participant agreed, speaking in general about events in UK HEIs:

Academic B (ML expert):

> *"Education is troubled and the digital technology changes very fast and platform implementations are higher and diverse. The university's capacity to supply diverse and up-to-date technology is very poor. Also, the idea that we have 300 desktop computers [or however many] sitting in a large room waiting for students to use is probably a bit weird and not at all the way students use computers or other digital technology in their real life."*

This comment hints are the suggestion current learning spaces may be less than ideal. The inability to cope with technological changes as well as its ready availability is also thought to be affecting the level of staff competency in terms of technologies. As mentioned earlier, many academic admit they feel overwhelmed when faced with so many array of technologies to choose from for designing instructional design and delivery. A learning technologist participant described the problem from anecdotal experience:

Learning Technologist U (ML expert):

> *"They [academics] want so much of my time and I am not able to give everyone the time they need … They are very self-centered. I know they want the best for their students … so they want to be doing this, and that for their students but they are not able to, and they are not able to get the technical expertise they need [from the institution or other areas]."*

Having had similar experience in own practice, the research can identify with this comment on several levels. On the issue of technological competence, many participants also suggest students may not be as competent as may be assumed by some. They may be increasingly "confident" and not as "frightened" of technology as they used to be, but a significant proportion struggle still, it is believed, to use MDT effectively to facilitate learning. An academic explained:

Academic C (ML expert):

> *"We have students coming to us from schools who are not technologically very good at all. Although, what it is, they're fine with mobile phones and with games in some respects, Facebook etc. But that's not being technologically enabled or agile. It's just being able to use your tool."*

One participant suggest assumptions are also being made about preference for MDT use in their learning, supporting findings from literature advocating students' preferences for ML should be determined and / or negotiated prior to process implementation (Shih, 2005; Corbeil & Valdes-Corbeil, 2007; Nerantzi et al, 2014):

Academic / Developer I (ML novice):

> *"It's also certainly not the case that just because learners use a tool in their private lives for fun entertainment and friendship; that automatically means that they wish to use the same tools formally for learning with teachers and it actually might be the case that learners do not wish to inhabit digital worlds or virtual places with teachers and would prefer to keep both places separate from … you know … from the business of education."*

Pressed further on how the issues identified may be addressed, an academic suggesting a way forward for universities in terms of MDT use mentioned another area of concern:

Academic E (ML expert):

> *"The other thing we can do is make sure … our learners … who doesn't know how to use that device well is supported in getting to a stage where they can successfully use it for their learning. So, I don't want to use the word 'competence' because it implies a stable thing: that when you become competent you always will be. And what we've seen with our learners is sometimes we can create situations where even though they are perfectly capable in theory, the way we design our networks mean they can't. So we can create barriers they can't overcome."*

This suggests the institution's network / learning systems may impose some limitations, perhaps as a result of security concerns and policies. This was a view also recognised as a barrier by Winters & Mor (2008; cited in Belshaw, 2010). Lack of competency was also expressed in terms of time availability and pressures as Beer (n.d.) surmised. In general, some think it should be about prioritisation. A member of the university board explains:

Governance M (ML novice):

> *"I think there is time issue. Everyone works very hard but I think it is about prioritising, interest, what the incentives are. Staff can do research when they want to do it, when they have the motivation to do it. If they know this is going to make their practice easier, rather than more difficult, I think they'll buy into it."*

This implies incentives are need to encourage academic engagement. Another member of the university board confirms this:

Governance L (ML inactive):

> *"There should also be some incentivising e.g. saying if you are interested in doing this, we can give you money to buy your time so you can do it and we've been doing that here. That will encourage them to do it more. At the end of the day, academics are communicators and all technology does is help them communicate better and for their audience to communicate back, resulting in a dialog and a 2-way conversation. So you will be pushing for an 'open door' where this process is encouraged from the very top."*

Some of the problems identified concerns about infrastructure provisions with regards to BYOD schemes. The feeling is more need to be considered in terms of execution; supporting similar suggestions in literature (Lennon, 2012; Dahlstrom & diFilipo, 2013). An academic noted:

Educational expert J (ML inactive):

> *"There is an annual BYOD survey that would suggest that majority of schools that was surveyed – about 300 schools – were happy with the idea of BYOD and would like to explore it because it saves them money. But then, you sort of find out that leaves a whole lot of barriers as well. For example, can they access the wireless system? Do the teachers know how the children can access the wireless system? So, little things like that … And I would suggest, given some of the things that I've been doing as well, that something simple*

like access the wireless system with a device is actually very complicated to make happen in schools."

Concerns about infrastructure provision was a common trend; all participants highlighting at least one issue with negative impact on MDT integration. This was also given as one of the reasons academics fail to engage with technology more:

Educational expert H (ML novice):

"It comes down to the fact that the stuff you want to do is limited by the infrastructure you are surrounded with and the technologies that exists in institutions like these. I mean, our computer system limits what you can do in collaborative connections."

When this was put to a member of the governing body in the same institution, he agreed there is a problem with infrastructure provision but believe a start has been made to address the issues with more to still to be done:

Governance L (ML inactive):

"When I first arrive here 2 years ago, we have wireless availability in the offices, but it was sporadic; there were lots of pockets of areas where you couldn't pick wireless. We've done a lot of work now to make it more universal across the university ... We are currently looking to replace those hard cover books with a tablet. So all students will have a tablet and on that tablet, they will have electronic versions of the core texts on their modules. But they will also have access to so much more; the VLE and other learning systems. So that is a policy that isn't in operation yet but it will be."

There is a mention here of another scheme now becoming common in universities. Tablets are customarily issued to, most commonly, first year undergraduates students and / or students on specific programmes such as Medicine, Pharmacy etc., as part of course programme provisions. A school / faculty dean expressed his concern about such schemes:

Governance M (ML novice):

"I was very critical at first, because I feel it hadn't been thought through. So, if

we give every student a tablet and they've got all their course books on [the tablet], then they come in the next day and say 'I've lost it'. Are we going to replace it? Are we getting every student insurance? And if they don't get another one, then they might say 'My friend's got one, I don't have one so I am not able to do my work' and so on. So how does that part work? So I think it's got to be thought through properly … but I guess it's a start."

Finding a starting point is a common default position among participants and many agree unanimously with schemes such as BYOD support and tablet issue in principle. However, all academic staff made a point of adding the caveat robust institution-wide support for these schemes needing to be driven and sustained from the top. In general all participants conclude a lot more need to be done in their respective institutions. A few other comments in relation to this may be worthy of note:

Academic C (ML expert):

"We are moving backwards I think. Very risk averse, short term outlook, quite conservative. If you go into the universities today, you will notice a clear difference from 10 years ago. Everything seem to have stopped with the advent of VLE and from then on, what we see is some sort of 'tinkering' with [emerging] web 2.0 type technologies without really changing anything."

IT support P (ML novice):

"To be fair, it [efforts] is getting blocked by all of the technological challenges [e.g. different platforms, rapid changes in technology]. Some of our operating systems do not work well with some devices and we can't really get away from that. Other things we are trying is to be able to connect their devices wirelessly in tutorial rooms ... So there are a few issues around the network infrastructure …"

Governance N (ML novice):

"I think we are still reacting rather than being proactive. The changes we are making are changes because the situation has become bad and we want to make it better. What we need to do when we get to the top of the plateau is to start making changes, you know, from good to great. So, you are not doing it any longer because you are in a hole you want to crawl out of. You are doing it because you want to enrich and get better and better. But we are not at that

stage yet.“

Table 6.7: Goal categorisation from responses

Soft goals	Participants' comments
Allow space for innovation	*It is about the diversity of thought and contribution ... We also need to bring in Deans and support Deans who have the capacity to innovate and transform the process.* *~ Governance N (ML novice)*
	What I could just start to see the beginning of, from the staff development that we do, is how what you can do with technology is making them [academics] re-think the way they do things and the way they teach. *~ Academic C (ML expert)*
	Take some of our most imaginative people and give them a weekend in a health spa – somewhere away from their busy lives – where they are just chatting with each other, talking to each other about how we could deliver better quality learning, about how they could make the best use of technology… *~ Governance N (ML novice)*
Digital learning space	*I think we just need to get the right tools. I don't think Moodle [a Virtual Learning Environment platform] is the right one personally; I don't think it's friendly enough or easy to use; not in comparison with Facebook for instance. I think we have to create an environment that is friendly and people are used to.* *~ Governance M (ML novice)*
	I wrote my [Master's] dissertation on ePortfolios and compared the available tools with what's offered on Facebook and there was quite a big disparity. The fact is if you don't provide these functionalities for them, the students will go out and find a platform that will let them do what they see others doing. *~ Learning Technologist Q (ML inactive)*
Determine students' needs	*I think they need to get students involved. There will always be students who do well at these things, perhaps reward them with vouchers and do some work among students to create awareness and perhaps start a movement going that way. They're the end user and we don't get them involve enough, get them to be part of the change agents.* *~ Learning Technologist Q (ML inactive)*
	I think at the moment, people are trying to do everything and not doing anything particularly well. So, it is a bit of hit and miss. They seem to be responding to what they think their students are engaging with, rather than stop and think what might be actually need. There is a difference … I think we need to find out what they really need. If you do and then start by fixing that and then building on that, we may be better off. *~ Educational expert F (ML novice)*
Remove limiting restrictions	*I think we need to reduce the financial performance element that is locking down so many courses / so many schools / Deans of schools like this one … reduce the element of accountability that requires bums on seats.* *~ Educational expert H (ML novice)*
	We also need to look at reducing the barriers, such as making it worth teachers' while – it's a selling job. Teachers need to be made aware that if you use this, it could not only make your life easier, but could make your students' lives easier too. You're going to be engaging with the students a bit more easily. *~ Educational expert J (ML inactive)*

Getting to "*the top of the plateau*", "*start making changes*" and then aiming to "*get better and better*" seem a desirable objective for all participants.

Recommendations for the future

Participants were encouraged to predict / suggest a future for ML and the use of MDT in learning. Opinions were also sought on drivers, barriers and the nature of the relationship between education and MDT in relation to co-evolution. Participants were also asked to suggest requirements for moving the agenda forward for integration of MDT in learning and teaching.

In the words of those interviewed, the following suggestions for the future (in Table 6.7) have been categorised to identify them with *softgoals* and quality dimensions that will be illustrated with models in Chapter 7. Asked if lack of funding, as was the case at the start of the decade, can be a barrier to ML's progress in the future, participants suggest "*throwing money at the problem*" is not necessarily the best solution, while admitting some considerable funding is necessary.

Governance N (ML novice):

> *"I don't think it is about that at all. Ultimately, it is about money but that's secondary. We need educators to start thinking in inventive mode."*

Academic B (ML expert):

> *"I think there is a variety of what I would regard as 'excuses'. But in fact, if all of those excuses go away, and you throw money at the problem, there are other underlying issues."*

All participants see economic downturn as a problem that could potentially impede ML's progress however. An academic remarked on the impact of tuition-fee reforms: "*We are conducting universities at the moment as if they are financial or business organisations … and fulfilling our financial obligations seem to be taking priority over everything else*." Another described the problem more succinctly:

Academic E (ML expert):

> *"In an ideal world, we'll have more staff, better infrastructure. At the moment for example, the physical cable network in our main building need to be replaced and the cost runs into millions of pounds. We can't spend that just*

on student support. But if we don't have a working network, we can't do our job, so we've got to do it."

Another academic suggest lack of funding is not only affecting infrastructure but support and staff development training provisions: "*There's only so much you can do without considerable amount of money allocated for training. So, we are not talking about a massive amount of support availability.*" A member of HE governance agree: "*We are in an environment where the government has decided we need 80% less money per student than we used to get, so we have to take tough decisions.*"

6.3.3. HE students as change agents

Educational expert J who is an academic on the secondary PGCE programme may have encapsulated this thought process best: "It is time to start to use [our] own students as the change agents and the agents of change in their schools when they go out to practice". There were many comments supporting this notion, not only about playing a part in transforming learning processes for themselves and others coming after them, but also effecting the changes they really need within the society. This and many other issues are explored in longitudinal surveys and focus group studies with students; conducted among two groups: new entrants into the university and pre-service tutors on secondary PGCE programmes.

The studies built on the comparison survey outlined previously in Section 7.3.1, which revealed several issues that may be barriers. For example, over 66% of the student respondents admit they use MDTs in their learning in comparison with 26% of the academic respondents who facilitate its use in their teaching. Regardless, it was not possible to generalise or infer students' expectation for MDT integration or the likelihood for use. It was also unclear if respondents fully understood the concept of ML. These and other issues requiring further investigations are explored in the findings presented next.

Freshers (new entrants) to university: findings

This study concerns new entrants into university called "freshers". The survey was conducted over one academic year. The following are the guiding questions for this study:

1. *What do students classify as 'learning' use of MDT and what's their understanding of ML?*
2. *If MDT is integrated in a more structured way in pedagogic processes, how would that affect students' understanding of the concept and their tendency to use MDT for their learning and more awareness of the benefits for their use?*
3. *Does factors such as students' level and discipline affect the tendency to use MDT for learning and awareness of the benefits for their use?*

Student participants were recruited during enrolment week, and subsequently via a questionnaire posted online on a university's Moodle (VLE platform) website at the beginning of the first semester of 2013 / 2014 academic year. Approximately 69% of student respondents online were September entrants; 48% of them agreed to participate further in the longitudinal study and were contacted. However, only 6 responded during the second phase of the review of this thesis at the beginning of the second semester. The decision was taken to recruit among the first year students from two disciplines and compare their responses with those gathered in the first semester.

Two groups of students from a Computing discipline (BSc Computing and Software Engineering) and Non-computing disciplines (BA Accounting, Business Management and Psychology) participated. During the first semester, students recruited online and during enrolment week were from a number of Non-computing disciplines. Table 6.8 provide demographical details for all student respondents for this study. There are some noticeable patterns that may provide insight into group dynamics in each case.

Table 6.8: Freshers' study (respondent demographics)

	No of respondent	**Age**				**Gender**	
Computing		18-26	27-35	38-44	45+	Male	Female
Semester A	16	81%	12%	0%	6%	81%	19%
Semester B	10	80%	10%	0%	10%	70%	30%
Non-computing		18-26	27-35	38-44	45+	Male	Female
Semester A	89	31%	26%	19%	20%	17%	81%
Semester B	36	46%	20%	14%	17%	33%	67%

The first concerns the average age of the cohort. Majority (81% in the first and 80% in the second semester) of the Computing students were between 18-26 years old while only 31% in the first semester, 46% in the second, of the Non-computing group are of the same age group.

Age has often been linked with MDT preferential use in literature and market studies; a market report suggesting millennials or generation Ys are more likely to take up and accept new technology (Rossi, 2014; 'Millennials', 2014). HESA reported they make-up over 75% of all enrolled students in the 2012/13 academic year (Universities UK & HESA, 2013).

An academic participant did not fail to notice this phenomenon, suggesting nowadays you would expect "*learners to come across mobile or computing devices at some point*". He however cautioned there are some "*minorities of people who don't have access to such devices or even if they do, they don't know how to use it well.* He added: "*If we presume too much, we risk failing that group.*"

In this study, there would seem to be less millennials in the Non-computing group; 57% and 66% under 35 years old in Semester A & B groups, compared to 94% and 90% in the Computing group respectively. This may indicate discipline related considerations are necessary when designing learning sessions for cohorts.

Table 6.9: Freshers' study (MDT ownership / preference)

	Mobile / smartphone ownership	**iPad / tablet ownership**	**Those with expectation for MDT use**	**Those supporting MDT use**
Computing				
Semester A	100%	70%	100%	100%
Semester B	100%	75%	67%	80%
Non-computing				
Semester A	92%	42%	73%	68%
Semester B	97%	85%	82%	91%

The second concerns gender which is also considered relevant in preferences for technology. Ofcom and We Are Apps studies in 2013 suggest device ownership and take up is rising among women. There are more female students in the Non-computing group (81% and 67% in the first and second semesters respectively) than in the Computing group (19% in the first, 30% in the second semester – see Table 6.9). Percentage values in Table 6.9 is based on each cohort group, and respondents may select more than one device option.

The third pattern concerns preference (or none as the case may be) for MDTs. It would seem Computing students prefer PCs, many of them owning and using their mobile devices at times for learning but very few owning tablets. Several also suggested PCs are best. Conversely, several among the Non-computing group own both mobile devices and tablets, some owning more than one. This may also be subject / discipline-related.

Fourth, the increase in expectation and support for MDT use by the second semester seem more noticeable in the Non-computing group. There are also more students owning tablet PCs in the second semester; there are in both groups but more in the Non-computing group. This may be because there were less students surveyed than during the first semester. It could also mean there is a greater appreciation for MDTs by the second semester of their study.

The latter may be assumed to be more likely as comments from two of the Non-computing students in the second semester may suggest, "*it saves paper and the environment*"; and also "*printing slides, lecture hand outs or extra reading can become expensive*". There were many comments from both groups about following the lecture by viewing slides / study materials on their tablet or mobile phones instead of looking at the screen or whiteboard. One of the Non-computing students said: "*from where I sit in the class, I can't see the slides on the screen, so I use my devices to view the slides*".

What do students classify as 'learning' use of MDT and what's their understanding of ML?

Arising from a comment by a content developer and a few academics interviewed for the review of this thesis, a set of questions about the use of learning apps were introduced during the second phase of the review of this thesis. The students were asked: "Have you downloaded any learning app onto your phone / tablet PC (e.g. iPad)?" A total of 75% of the 30 student respondent in the Non-computing group admitted they've downloaded a learning app which they used fairly regularly on average. Several of them (23%) named one particular app called '3D brain app' which they rated as "*interactive*", "*very informative on brain sections & locations*" and "*good for revising … on the go*" etc. When the academic facilitator for the module was contacted for further clarity afterwards, it was discovered the app was suggested in a session at the beginning of the semester as a useful tool to download. Many of the students seem to have downloaded it.

During interviews, an academic recounted a related experience:

> *"I was teaching some practical skills to some students and one of them had on their phone anatomy notes, an app that they've downloaded and it actually gave them the information they needed on things like muscle attachments … there was a picture of a joint and so on. So while they were working in a practical class, on their mobile phone they could see the anatomy. I thought that was a really good way to extend the learning because it kind of blend in the practical skills they really needed with the theoretical at the same time."*

When the academic was asked if he ever tried to look into using other apps afterwards, he admitted he didn't: "I have to admit that was something the students thought about; I mean I wouldn't have thought about it. But that to me was very useful and it generated a lot of learning."

Table 6.10: Top factors for achieving mobility, adaptability and flexibility in learning

Learning anywhere/at anytime	74%
Good learning materials	74%
Wifi enabled devices	73%
Using online applications	66%
Good teaching	63%
Using emails and texts	62%
Learning with friends	61%

Judging from the findings from the focus groups conducted with pre-service tutors and existing literature, it was recognised that while many students may understand or recognise some attributes of an ML process, many seem unable to describe or agree on what classify as one. Therefore, understanding of ML was determined by asking the students to suggest how *mobility*, *adaptability* and *flexibility* can be achieved in a learning process. Many of the students agree the ability to ‘learn anywhere and at anytime’ as well as WiFi-enabled devices may help. Several also selected other items such as ‘good teaching’, ‘using emails and texts’ and ‘learning with friends’ (see Table 6.10 for the top selections).

If MDT is integrated in a more structured way in pedagogic processes, how would that affect students’ understanding of the concept and their tendency to use MDT for their learning and more awareness of the benefits for their use?

The response of the student cohort when the ‘3D brain app’ was recommended during learning sessions as a learning aid may be an indication to support the necessity for a more structured integration. Some of the comments would also seem to support this. When asked why they would or wouldn’t use MDT in their learning, some of the positive comments include the following:

> ***Student A1:*** *“It gives quick and easy access to learning, able to take notes from lectures and to record lectures if permitted.”*
> ***Student B1:*** *“I do because I am allowed, well, my course is already a distance course designed to be run online.”*
> ***Student C1:*** *“It makes things quick and easy! Checking things on Moodle [VLE] for example. Researching on the spot during lessons is another key point; imagine being able to have the library in your hand at all times. This is 2013 so let’s start moving the university in the correct direction for both students and lecturers.”*

The last comment may suggest a desire or willingness among students to become one of those change agents discussed earlier in this section. As may be expected, some of the negative comments relate to classroom disruption, device limitations and less than robust infrastructure / internet connectivity:

> ***Student A2:*** *“My mobile's screen is too small to read large amounts of text - insufficient memory. Internet can be slow and patchy.”*
> ***Student B2:*** *“Not during lecture/seminar time but I would use them in the*

library.

Student C3: *"I probably wouldn't because I prefer taking notes by writing them myself as my smartphone or a tablet would distract me."*

Does factors such as students' level and discipline affect the tendency to use MDT for learning and awareness of the benefits for their use?

Findings related to this have been discussed earlier in terms of how the make-up and grouping of age and genders may be different for each discipline. However, relevant findings about the effect of levels will be discussed later in subsequent sections on observational studies.

Pre-service tutor programme results

Student cohorts on Non-computing (Modern Languages) and Computing secondary PGCE programme were selected for this study which involved two focus groups studies held at the end of Semesters A and B with the cohort groups in separate sessions. There were 8 students in Non-computing; 1 male, 7 females for both studies. The Computing group consist of 8 students; 4 males, 4 females in the first study and 10 students: 4 males and 6 females in the second. Those in 27-35 age band make-up 50% of the Non-computing group for both studies. The same goes for 50% of the Computing group for the second study; for the first study, 38% each belong to 27-35 and 38-44 age bands.

Questions were designed to determine their experience during placement and perception on how the PGCE programme was supporting them in their practice. There were three set of hypotheses guiding this study:

1. *That pre-service student tutors require that MDTs as well as new technologies are integration in a more structured way in their pedagogic processes to utilise them to improve teaching and learning in their own practice,*
2. *That pre-service student tutors require that the training provide adequate and ongoing training / support about ML, and*
3. *That the use of MDTs build the capacities of teachers and support their work with students.*

The students go out on teaching placement to various secondary schools in the UK twice during the year. Three focus groups sessions were scheduled with both groups: one at the start of the year before their first placement and two after each placement at the end of the first and second semesters. Unfortunately, the Modern Languages pre-service tutors were unable to attend their first session at the start of the year due to strike actions. They were able to attend subsequent sessions after both of their placement stints. Sessions after placement were held about a week or two after the students return.

Discussions and scenarios

A semi-structured discussion style was adopted during the focus group to encourage the students' participation. An initial discussion activity, designed around fictional scenarios about three different tutor characters was used as ice breaker. Discussions began by inviting the students to comment on how the particular circumstances of these tutors may affect their practice in terms of MDT usage. This provided some useful insights into the students' thinking while guiding them to reveal more about their own practices and perceptions. Subsequently, students were prompted further using specific questions about their practices, circumstances in their placement schools and the PGCE secondary programme.

Students were initially asked how they thought the scenario subject's background may affect their practice in terms of preference for integrating MDT. See Table 1, Appendix 7 for details of responses. After their placements, it was clear the students are now able to reflect and relate with the scenario subjects, identifying some of the similar characteristics in themselves. The Modern Languages students did not have a focus group session before their first placement so it is unclear if they would have held a different opinion on the subject of inequality at that time. However, they seem more appreciative of the inequality aspect and most seem to agree with Miss Brimstone on the issue. One applauded Miss Brimstone: "*She's putting the children's needs first and realising potential dangers*".

Some however feel there are so many choices of great handsets and it doesn't really matter anymore which one the students have while others feel care should still be taken to ensure there are no inequalities. The students were prompted further if they thought the subject scenario subjects are teaching or their discipline background might have an impact on preference for integrating MDT in their teaching practice.

In general, all students in both groups believe some usefulness can always be found for MDT use in any discipline, but admit some disciplines may offer more readily apparent opportunities; such as Geography, the subject taught by the fictional Mr Pitt in the scenarios. Students on the Computing group were quick to identify GPS affordance on devices, used alongside Google maps, may be beneficial for teaching Geography topics. The Modern Languages students mention MDT is very useful in languages and 2 recounted specific instances of their use. See Table 2 and 3, Appendix 7 for details of responses.

Next, the pre-service student tutors were asked if they thought the TEL conference all three subjects attended was adequate to provide them with the skills they needed to use MDT effectively in their practice. Most of the students in both groups seem more interested in discussing Mrs Buttercups' expertise with technology (or lack) and believe she will need a lot of training. When pressed about other scenario subjects, they agree they will need training too but Mrs Buttercups more than the others.

When asked why, one student in the Modern Languages group sums it up: "*I think the older you get there are challenges. It is a generation thing.*". All however agree the conference is not enough and stresses the importance of making sure learning objectives are prioritised before selecting technology; agreeing with those interviewed on this subject as discussed previously.

The students were next asked if the scenario subjects' use of MDT could build their capacities as teachers and support their work with students. More clarification was needed on the question "*Would you say mobile technologies build the capacities of teachers and support them in their practice teaching?*" for the students in the Computing group initially, before their placement teaching started. This changed during the second and third sessions when students reflected on own practices as shown in Tables 1, 2 and 3 from Appendix 7. From the responses of the Modern Languages group as well as the Computing group, there seem an indication they have reflected on these issues and what they would do in future, agreeing the use of MDT can enhance their practice.

All PGCE students, including Computing and Modern Languages cohorts attended an hour's lecture given on TEL and integrating technology in general into teaching and learning at the beginning of the semester; also attended by the researcher for the review of this study. The session was conducted using PowerPoint slides of generic information on different technologies, outlining advantages and disadvantages of their use in teaching. Requirements for the first assignment on researching TEL for use in learning and teaching which is due at the end of the first semester was subsequently discussed with students at the end of the lecture.

The students were due to go on placement the week after the TEL session and the assignment on TEL was due when they return in February after their placement. Therefore, the students were prompted if they thought the TEL session and any other learning sessions they attended so far was enough preparation for their placement activities and assignment. Only the Computing group students were asked this question before their placement and the general indication is they seemed optimistic at the time, one stating: "*I am more aware now of how mobile devices can be useful in teaching*", and another saying "*I know where to go to if I need more resources*".

When the students returned from placement teaching however, the story seem different for both groups. All the students realised the one TEL session was inadequate to prepare them. One said: "*We were just given a lecture on TEL and given an assignment to do on using technologies in teaching. Nothing else*". Another said: "*I think we could have done with some introductory sessions on using several technologies*". This issue was raised with the programme tutors and responses discussed later in this section. See Table 5, Appendix 7 for details of responses.

Common threads and patterns

A common thread which seem to have restricted the activities of the students is the ban imposed on mobile devices in many of the placement schools and the general lack of experience or active participation among the students' mentors with using MDT or other technologies for that matter in teaching. All students reported there was a ban imposed on mobile devices but most admitted they used iPads and smartphones during their preparations.

During the first studies with both groups after their placement, a few admitted they used MDTs to facilitate their teaching sessions, allowing students to use their mobile devices during the session in spite of the imposed ban. The following is a statement made by one of the students in Modern Languages group:

> ***Pre-service tutor 1 (Modern Languages):*** *"I used an ML [Modern Languages] app, it's called a 'random nameselector'. It's on iPhone. I used it with the kids."*

Following this statement, there was a discussion about the usefulness of the app in question. A second participant added:

> ***Pre-service tutor 2 (Modern Languages):*** *"I've used that app too … with students. It is very good."*

Having originally indicated he wasn't able to use MDT with his students, the latter was asked if the app was used while on placement and he admitted it wasn't but that he's used it in the past. When prompted further if that meant they were willing to risk violating the ban on occasions:

> ***Pre-service tutor 5 (Modern Languages):*** *"I think it depends on the schools and the policies within the schools. If the school is really progressive then the tutors will use technologies and guide the students as well."*

Another said with a laugh:

Pre-service tutor 1 (Modern Languages): "Yes, if you are up for the challenge."

In general, there seem to be more activities among students in the Computing group with regards to the use of MDTs on their placement though all of them also had mobile phone ban policy in place in their schools. One stated:

> ***Pre-service tutor 1 (Computing):*** *"My school had that policy but I just ignored it …"*

When asked to clarify, he said:

> ***Pre-service tutor 1 (Computing):*** *"I always allow them to use the phones to take pictures for use in their assignment or take pictures of assignment written on the whiteboard for their use later … Well, I just trusted my students to use the phones responsibly and the result of their work proved they were using the phones for their learning. I didn't check to see if they did other things. In this case it was really the only way they could complete their work."*

This seem to imply there are some concerns about responsible use. When prompted further, a participant explained:

> ***Pre-service tutor 2 (Computing):*** *"Because it is something which can distract the kids as well as help them so you need to think about behaviour as well ... It does depend on their age group. Younger kids may be difficult to control, on the internet, texting. The kids in my group sometimes need to use their phone in class but you find them going through their personal emails and the phones had to be taken away from them."*

Another participant added:

> ***Pre-service tutor 3 (Computing):*** *"I had a year 10 class and we were having a voice over [learning activity]. They had their phones so I told them to bring out their cables [headset]. But some of them got into text messages and were showing each other … so I had to stop and remind them that if it carries on, they won't be able to use their phones anymore. I was only able to do that because I prepared myself because my mentor told me to. But if I was to experience that without thinking about it first, it may have been difficult to*

control the class."

A participant explained how she controlled her class:

> ***Pre-service tutor 4 (Computing):*** *"What I did to control the situation is I got into a habit of walking into the classroom with 3 or 4 different handsets … and I would pretend that I had confiscated them from other students. That worked really well … the students made sure they kept their phones out of sight once they see that ..."*

When asked why she felt she had to do that, she said:

> ***Pre-service tutor 4 (Computing):*** *"It was just my way of getting them to behave and obey the school policy … It is always on Fridays, they seem to have more to say to each other on Fridays and once they get going … you have to keep a handle on things. So I always have this story ready for them – the biggest thing for them is not to lose their phones ... The problem is once you let them take it out of their pocket, they are bound to abuse it and use it for other things. So I had to learn to keep control of the problem … It is easier."*

The Computing group were also prompted further why some of them risked violating the ban on mobile phones and one of them explained:

> ***Pre-service tutor 5 (Computing):*** *"I find that … I find personally, it depends on personal preference as well. For example, in my previous career, I was a programmer. So I … when I write programmes, I often use headphones to shut out the noise. So if kids in my class want to use headphones, I am comfortable with that because I know it doesn't necessarily stop them from learning. But I find that other teachers would stop kids using headphones saying they won't concentrate … so it depends on what you are used to. And other teachers just don't like the 'faffing' around …"*

The students all admitted the mobile phone ban policy is more to do with classroom control than anything else and when they do need to, many seem content to just ignore the policy. Only two of the students think the idea too restricting. One suggested:

> ***Pre-service tutor 7 (Computing):*** *"I think it also depend on how you prepare for your lesson as well."*

A student who had previously admitted to risking a violation of the ban policy agreed:

> ***Pre-service tutor 1 (Computing):*** *"I would agree with that. I always ask the kids before the day to bring their own cables and phones for the lesson So, even though they all had different phones, iPhones, Blackberry, Samsung etc … every phone had a recording and image capture tool. So they were all able to use their phones to do what I needed them to do. But if I didn't tell them ahead of time and just told them there and then on the day to bring out their phones … they might have just said 'Oh, I don't have my cable' or other things … I don't think it would have worked."*

Pre-service student tutors require that MDTs as well as new technologies are integration in a more structured way in their pedagogic processes to utilise them to improve teaching and learning in their own practice

It was clear the students needed some support and guidance on how to integrate technologies effectively. More than one member of the groups also commented on the need to see the use of the technology in action rather than just being told or lectured about them. At the beginning of the year, they were quite optimistic. A student in the Computing group commented: "*I know where to go to if I need more resources.*" Once they started going out on placements however, the tune seemed to change. At the end of the first placement, one member of the Computing group said:

> ***Pre-service tutor 5 (Computing):*** *"I know there are so many things we have to learn ourselves, but I still think the tutors could have taught us a bit more on how to use several technologies effectively before we went out to teach. We needed to be introduced to a sample of them and interactively use them … We need to practice on some of them."*

When polled, all agreed with this assessment. It was the same on the Modern

Languages group where two of the students said:

> ***Pre-service tutor 2 (Modern Languages):*** *"I think there should be more training on technology integrated more into the programme. Don't get me wrong, our tutor was great but we needed more time to practice with different types of technology and how to use them. We just learnt the theory and some of the benefits but we didn't really get to practice using them."*

> ***Pre-service tutor 5 (Modern Languages):*** *"My computer survey [module evaluation] that I filled in beginning of this week, I put poor for technology. I was very honest about it because I don't feel that I was trained on technology."*

These comments were reported to the programme tutors, their responses as follows:

Programme tutor – Computing Secondary PGCE (Educational expert J):

> *"Some of them get offered 6 weeks' conversion classes, but that may not be enough sometimes. Perhaps we should do more."*

Programme tutor – Modern Languages PGCE (Educational expert R):

> *"Maybe we should address it [the issues] more … We re-write the course all the time. We hold focus groups during the programme to access how it is running and from all the feedback, we re-design the programme for the following year."*

This reflects the sentiments of many of the academics on the PGCE programmes interviewed for the review of this thesis. The general impression is they all consider the PGCE programme fit for purpose as a result of its adaptability to suit learners and other relevant parameters. An academic summed this up:

> *"I think the PGCE programme is [fit for purpose]. It is a good programme where you have a nice mixture in 36 weeks. It is mainly based in schools, 24 weeks in two contrasting placement schools and then the rest of the time is made up at university where we give them like the general studies as well as subject input ... There are lots of different routes into teaching, but I think this is the one that is preferable because it means learners are in schools; they are*

'supernumerary' and they have someone with them all the time. They are being given informal advice and guidance as well as being formally advised."

Contrasting PGCE programme with GTP (Graduate Teacher Programme), the academic added:

> *"In the old GTP [Graduate Teacher Programme], most trainees tend to find it a bit difficult to start with because they are not 'supernumerary'; they don't have to be. So they end up just being dropped in the classroom and told to get on with it."*

Another academic on the PGCE programme agreed with caution:

> *"I have to comment based on the discipline I work in. I think that we do a good job within the constraints but yes, I am saying our system is not flexible enough to allow that. For instance, the Education Minister talks about prioritising research, but it is impossible to encourage our students to undertake rigorous research within the time-frame they have to be trained to become a fully-fledged teacher."*

On the time-frame issue highlighted as a problem in this comment, another academic on the PGCE programme agreed with the assessment, adding: "*In teacher education, we have a problem about time to train the teachers and as a lecturer, I would love to be fully conversant with technology, but it is largely left to me to do that and find time for it within my schedule.*" Pre-service tutor student participants on the review of this thesis found this was a drawback, suggesting more could be done as discussed earlier in this section.

There are contrary opinions however on the adequacy of the level of technological support provided to PGCE students. When prompted on the issue, an academic responded: "*I would say more and more we are providing adequate support in that area – certainly in the PGCE programme. I wouldn't know much about other subject disciplines but I would disagree that we are failing in that area.*" It is this mis-match in opinions, supported by findings from literature (e.g. Kukulska-Hulme, 2010), that was the basis for the comparison study which formed part of the foundation for this research, and is perhaps typical of issues in the domain. HEIs, academics and learning support providers may make inaccurate assumptions on how well they are doing for policies and strategies. This aspect will be considered in more depth in Section 7.4.

Pre-service student tutors require that the training provide adequate and ongoing training / support about ML

The necessity for sustained training support from the institution was clear in the previous section. However, the pre-service tutor students were also failed in the placement schools where there was very little or no support. Asked if any member of the group got further training on using the technologies available in the school and perhaps opportunities for further training on others and all the students without exception said there wasn't. In fact, none of the students were offered induction on the technology available in the school when they started: "*They gave me a tour of the school but that was it*." A member of the Computing group added:

> ***Pre-service tutor 4 (Computing):*** *"I don't think they can teach us everything, plus the situation in each school will be different. The IT setup and the whiteboard in my school were very different from what we had here … [However] there's no support and no one to go to if anything goes wrong … What would have been useful is if in the initial week of your placement, you had an induction on the IT system and the technology available."*

All in the group agreed and there was a rather lengthy discussion on the dismal (sometimes "*nightmarish*", in the students' opinion) IT environment encountered on their placements. A student summed it up: "*I think we needed to be told what we would have to work with.*" Members of the Modern Languages group didn't fair any differently. A student reflected on her experience:

> ***Pre-service tutor 1 (Modern Languages):*** *"I think if there was an induction at my placement for instance, I probably would have found out there was a software for the Whiteboard after all because the tutor I asked didn't know. He just told me there was no software for it so he doesn't use it. But I found out the Maths teacher always used the whiteboard. So, I think an induction is very*

important."

A couple of other students agreed, adding:

Pre-service tutor 7 (Modern Languages): *"Yes tremendously; like how to use the whiteboard, how to logon to the WiFi, how to get around the network … stuff like that."*

Pre-service tutor 3 (Modern Languages): *"We needed more time in schools to find out how stuff works. Managers in the school have to attend a course that isn't compulsory here so they don't care … but we pay lots of money and don't get the training from them."*

The last comment was in reference to the mentoring programme which pays some of those in schools to mentor the PGCE pre-service tutors on placement in their schools. The fact that the mentors have the option not to attend the training offered by the HEI is also noted in the comment. More on this will be highlighted in the next section.

Placement schools conditions: Mentors and technology champions

Another common factor related to the expertise of the placement school mentors. Each student is allocated a mentor within the placement school who is supposed to guide the pre-service tutors in their own practice. One of the students on the Computing group revealed:

Pre-service tutor 8 (Computing): *"I didn't even know there was a whiteboard in my class to use until the last week … and I had to work it [how to use the whiteboard] out myself. I think the school [or our mentors] should have told us about them but they didn't."*

Another student agreed, adding:

Pre-service tutor 7 (Computing): *"My school had a 'no phones' policy but in my class, phones are allowed so long as they use them appropriately. I know my mentor doesn't allow it or use it but I do."*

Many students reported they hardly see any of the existing tutors using any other technologies apart from PowerPoint and projectors. The situation seem common with both groups. A member of the Modern Language group explained:

> ***Pre-service tutor 3 (Modern Languages):*** *"I think it depends on the mentor. My mentor wasn't really technologically savvy so she didn't do anything with me really. In fact, she shied away from it. For example, they had a whiteboard but no one actually used it. I had to go round trying to find out who knows about it and if they could teach me. My mentor didn't have a clue."*

Another student agreed, recounting her experience:

> ***Pre-service tutor 2 (Modern Languages):*** *"That's true. The teachers themselves don't know. I was told the whiteboard was just there and they didn't buy the software so I couldn't use it … and then there was a Maths teacher who was using it one day so I watched."*

A student explained the possible reason:

> ***Pre-service tutor 7 (Modern Languages):*** *"I think they just get funding and buy these things. Maybe they use them for a while but then stopped. My school had a VLE [Virtual Learning Environment] but none of the teachers put stuff on it for the pupils and I doubt if the pupils know how to log in to the VLE."*

In response to this statement, one of the students said "*My school don't even have a VLE*". Another student stated:

> ***Pre-service tutor 1 (Modern Languages):*** *"My opinion is a lot of teachers who've been there for so many years haven't actually moved forward or changed the way they practice."*

When this issue was raised in a question to one of the programme tutors during an interview, she admitted the mentors commonly fail the students on occasions, adding:

Programme tutor – Modern Languages PGCE (Educational expert R):

> ***“****And that’s despite the fact that we bring them in here and train them to support the pre-service tutors, and we also send training programmes to schools with a list of technologies that we want the pre-service tutors to use. But sometimes, they come back and said they didn’t get to do all of those things ... And this is the thing, if the mentors aren’t leading by example, then the tutors aren’t going to use them. So, yes, it is a real problem.****”***

She added: “Sometimes schools have all these technologies installed but never give time or CPD for teachers to learn how to use them effectively or even to encourage / promote their use”; suggesting support from Schools’ governance may also be lacking.

Placement schools conditions: Infrastructure provisions

Available infrastructures, or lack of them as the case may be, is another common complaint in both groups. The problems were discussed during the last focus group sessions with both groups after their placement. Some of the students in the Modern Languages group commented:

> *“I had a reduced access to IT in my second school as they didn’t have as much facilities as my first so it wasn’t implemented into lessons.”*

> *“My school was outstanding [OFSTED rating] but there was only one classroom where there were computer terminals but the way people used ICT was very limited, it wasn’t very advanced. The rest of the classrooms had nothing at all. For an outstanding school it's so very outdated.”*

> *“My first school had mini laptops for children. In my second school, there weren't even laptops for me. We had a computer which you had to switch on and wait half an hour.”*

All laughed at that comment. There were more of the same from the Computing group:

"The network system in the school could be a big problem as well. Some schools have WiFi but only few people know the access details and I wasn't told it until I asked … Some don't have the programs you need installed and you have to do extra work to get it to work before the lesson."

"My first school was really good. They were encouraging students to use technology, especially Raspberry Pi and iPad which all the teachers were already using. The second school had nothing in comparison really."

"In the first placement, students and teachers both used Google apps. It was only allowed for the A-level students. They recently invested in the infrastructure. In my second placement they didn't have anything, they were working on it."

"Ok there's this room and all the walls are glass and fits up to, I think, 200 people … so, like a massive computer room. That is known as the VLE. I didn't try to change the perception. When businesses come in they do display it and go: 'Here is our VLE'. But it's basically just a glass house for after school / lunchtime learning. They got funded for it but I don't think they understood the initiative."

When asked for more clarity by another student, he responded:

Pre-service tutor 3 (Computing): *"I think my school got confused about what a VLE is. What they have is a room full of computers which they keep locked up. And then they say things like: 'We've got a VLE' or 'Let's all go to the VLE room' or 'Get the key for the VLE room and take so and so group to the room …' I was so excited when they told me they've got VLE but disappointed when I saw what it actually was."*

Asked how they felt about the disparity between the schools and the response from the Modern Languages group was:

Pre-service tutor 6 (Modern Languages): *"It was really hard but I had to keep alternatives planned because we had gotten so used to it."*

Those in the Computing group had similar responses about technological infrastructures in their placement schools.

The use of MDTs build the capacities of teachers and support their work with students

While students in the Computing group seem confused by this question when it was first asked with relation to scenario subjects during the first focus group session, the students seem to understand the question better subsequently. It was assumed this was due to the fact that students have now been on placements and are now able to respond from own experiences. When those who facilitated the use of MDT were asked to comment on this, a member of the Modern Languages group said:

> *"Yes, I am trying to practice using some language apps. I think it helps only if you keep up with it."*

> *"My second assignment [for PGCE assessment] was on an interactive white board and as I got into it I realised it was such a powerful tool and how many applications it is connected to and it could definitely bring alive your teaching and enhance your learning. I think you should take ownership of your own learning but time is needed."*

One of those who said they were unable to use MDT as a result of the ban said:

> *"I think we have to find a way round the issues because I think it is the way forward. I've seen how much it could help in the 6th form classes. They are allowed to have their phones and I have a friend who teach on the 6th form. I know he uses mobile phones a lot with his students."*

A student on the Computing group stresses the fact that pre-service tutors need to take charge of their own Continuing Professional Development (CPD). She added:

> ***Pre-service tutor 2 (Computing):*** *"We need to imagine how to use technology well now it's a lot more visible and some options are open to me that were not open to me before. I need to learn about these options."*

Both groups were polled on the issue and many of the students agree MDT may help their practice but are concerned in general about finding the time for the training and development that may be necessary alongside their teaching schedules.

Observational studies

Observational study was designed to determine the validity of some of the issues identified from previous findings. For example, the comparison study among academics, students as well as those in learning support and governance conducted highlighted some issues relating to disruption in classrooms and discipline-related issues regarding the use of MDTs. There was also some underlying theme suggesting MDTs are not facilitated in a conscious way in sessions.

According to Holly et al (2000), "*observing user in the field is always the best way to determine their usability requirement*". Observation allows the observer to play a variety of roles while observing how the user and other subjects in the research field interacts within a particular system. In this instance, it was necessary to get a picture of how classroom sessions are managed with relation to MDT integration.

The following questions were formulated and used as guiding principles:

1. *Do the use of MDTs cause disruption in learning sessions and what is the nature of these disruptions?*
2. *How are these disruptive situations handled by both academic facilitators and students, and what are the causes of these disruptions?*
3. *Are students allowed and encouraged to use MDT in their learning sessions across the university and is this practice uniform across disciplines and sessions?*
4. *Do students perceive the practice as helpful for achieving learning objectives and / or improving their attainment on the course programme?*

Teaching session observations were conducted within the last academic year (2013/14) while informal practice observations occurred throughout the life of the review of this thesis. The implications of the researcher's role as the observer as well as a member of the domain being observed was discussed in Section 3.7.2.

Teaching session observations

Sessions were selected at random and sometimes observed from 'mystery shopper' perspective. Except in two instances, neither the academic facilitators nor the students were informed about the study until afterwards, when it was necessary to interview the academic facilitator or some of the students. Those informed prior to attending the sessions were told the purpose was to talk to the students afterwards about participating further in the study. Thus, the exact nature of the observation was not divulged to the participants to ensure observed behaviour was authentic.

A total of 5 sessions were observed in Psychology, Arts and Digital Industries, Computing and Engineering, Education and the Social Sciences modules. Details of the findings will be outlined next in the following sections, to maintain anonymity, specific identifying details about the sessions will not be provided in line with the directives of the ethics approval for the review of this thesis and to protect the participants.

<u>Observation results</u>

Table 6.11 provide some more details about the sessions. Sessions lasted from 60-90 minutes. In all the cases, the researcher just walked into the session and was not challenged by anyone; usually there before the tutor arrived.

Table 6.11: Session observation disciplines

Session	No of students
Psychology module	115
Computing and Engineering module	16
Social Sciences module	30
Arts and Digital Industries module	25
Education module	265

In all the sessions, students were able to use their smartphones or tablets freely. Most students seem to prefer smartphones rather than tablets in general. There were a few with laptops, especially in the Computing and Engineering module but as many as I would have expected.

Only in one instance (during the Social Sciences module session) did the tutor refer to the use of devices in anyway. About halfway during the session, the tutor mentioned, almost in passing that students should stop ‘playing’ on their phones and listen instead. All the students seem to ignore the admonition, some looked up briefly and simply continued as before a few minutes later. The researcher was sitting next to a couple of students, one of who had an iPhone and the other a Samsung tablet. A surreptitious glance across showed they were both on the university’s VLE (Virtual Learning Environment) website.

After the session, a brief chat was initiated with some of the students to find out what they were really doing with their devices. A few admitted they were checking their email; one said she was sent a text during the session and another said she was responding to a Twitter message. Several however said they were looking at more information on the topic. Asked how they felt about the tutor’s admonition and one shrugged. A student remarked: “*We are used to it*”; and one added: “*It is unfair really, isn’t it? We didn’t do anything wrong*”.

Asked if they’ve had similar experience on other modules and a few had some anecdotal stories about being thrown out of the class or having their phone confiscated until the end of the session. The latter smilingly admitted she had the phone headset in one ear was playing her music too loud. When the tutor got closer to her, she heard the music and got angry, asking her to leave the phone in front until the end of the session or leave the class, she chose the latter option. Clearly, such behaviours are likely to fuel support for bans.

One of the students said he was told to stop using his laptop only the previous week in one of his classes but he also admitted he was showing a video (which had nothing to do with the session) to a ‘mate’. Another have decided to stop using her smartphone in class because “*it could be distracting*”. In one session which occurred in a lecture hall with over 100 students in attendance, some of the students sat at the back so far away from the rest of the class. To understand if this made a difference, the researcher moved to sit at the back with some of them.

There were three students, one of who had a laptop and the other with smartphones. It was impossible to see what the third person sitting farther away from the researcher was doing but they all seem to be chatting about what the tutor was saying in front and the one with the laptop was making some notes. Although it was unclear if the notes were on the lesson but it seemed it could be because she would look up at the whiteboard from time to time. In many of the sessions, those who sat in front occasionally take pictures of the whiteboard display especially when the tutor makes adhoc notes on the whiteboard.

Discussions and conclusions

The classroom observations and other observational experiences during the review of this thesis were very revealing in many ways. None of the disruptions described were personally witnessed by the researcher during the study. While the students seem distracted they were well behaved for the most part. However, students admitted to behavioural issues to do with MDTs during informal chats. Students were generally left for the most part to choose what they wanted to do.

In one of the classes the tutor ask one of the seemingly distracted students a question. The assumption is this may be to check if she was following. A friend sitting next to her whispered the answer, which may imply she was busy doing something else. Once the student was able to answer, the lecturer moved on without making any further comment, although it may have been obvious to him the student didn't really know the answer.

With the exception of this particular incident, the general 'observed' impression is students may occasionally be distracted, 'play' or do other things on their handsets. However, they seem also capable of concentrating and making sure they follow the session, or they appear to be. Therefore, creating a policy around MDT and awareness about responsible / acceptable use may go a long way to ensure students use them more to support their learning. It is also possible students "play" on their MDTs because they find the sessions boring, as have been suggested in literature (Inderbitzin & Storrs, 2008; Mann, 2009; Lord, 2012) and by more than one student in the review of this study.

6.4. Comparison of results between studies

One of the frameworks underpinning the review of this thesis is a determination of requirements by identifying perception similarities and opinions about factors and issues within the domain of ML. There were perception comparisons between stakeholders, technical subject / discipline i.e. a subject considered to be knowledgeable about technology (.e.g. Computing) and Non-technical subjects such as Psychology, Accounting or Modern Languages, age and gender. Age and gender is also further triangulated with subject discipline for greater understanding. Age, gender, subject / discipline have been identified in literature and from market trends as those which may affect MDT preferences, usage and expertise. Understanding this aspect could be useful when creating instructional designs for MDT integration and ML.

There were some findings related to this track, some already discussed in previous sections and supported by empirical evidence. This section summarises some of the highlights of these findings.

HE governance / learning support / academics Vs students

This study found there were often similarities and differences in the perceptions of stakeholders about several issues. For example, the initial comparison study found similarities when stakeholders described uses of mobile devices by themselves and / or friends and colleagues, suggesting usage is generally for informal learning:

> ***Learning support / governance:*** *"(1) The ALPS project - occupational therapy videos delivered in the field via mobile devices. (2) In informal learning setting mobile devices are used extensively. I have published a paper on craft*

brewers using devices in proceedings of networked. (3) As a catalyst for student-generated content and student-generated learning contexts."

Academics: *(1) Note taking, viewing videos, accessing VLE, translation dictionaries, using social media. (2) iPad used to make notes during lectures. (3) Commenting with each other; podcasts and iTunes. (4) Recording homework in calendar, recording evidence. (5) During class to pull up info, accessing material (e.g. podcasts we provide).*

Students: *(1) They use them for listening to podcasts and to record their own voice. (2) Study groups accessing library info. web searching. (3) Same way as I do and we link up for topic discussions and knowledge exchange. (4) To create study groups, to SMS questions to tutors.*

There are also differences. For example, when asked to rate barriers to ML, top three for each group of respondents show while academics and those in the role of learning support agree, students think differently:

Learning support / governance: *(1) Lack of supporting technologies / software. (2) Inadequate IT support in institution for use in learning. (3) Lack of WiFi or Bluetooth connectivity.*

Academics: *(1) Lack of supporting technologies / software. (2) Teaching not designed for ML. (3) Inadequate IT support in institution for use in learning.*

Students: *(1) Device battery life. (2) Expense of suitable devices. (3) Limited accessibility & ongoing running cost.*

When asked to rate drivers for ML, the same pattern seem to emerge with more similarities between academics and those in the role of learning support. Students agree on '*Quick access to learning content / materials for students*' being important but chose different items for two of the top spots:

Learning support / governance: *(1) Quick access to learning content / materials for students. (2) Provide access to information in remote locations. (3) Quick access to social networking sites / email etc., for students.*

Academics: *(1) Can motivate hard to reach students. (2) Quick access to learning content / materials for students. (3) Provide access to information in remote locations.*

Students: *(1) Quick access to learning content / materials for students. (2) Timely communication with students / peers. (3) Can positively enhance /*

support learning processes.

The findings of the study among student 'freshers' (newly enrolled in university), differentiated on technical and non-technical disciplines, also revealing some similarities and differences.

> ***Student NA:*** *"I use my mobile and tablets in class to access lecture slides and / or other Moodle (VLE) resources and to take notes."*
> ***Student NB:*** *"I used my iPad to look up something I don't understand, see information from lecture quicker, read designated ebooks ..."*
> ***Student NC:*** *"It helps me to learn French and German, to reference."*

The differences seem apparent in preference. Students on Computing programme said:

> ***Student CA:*** *"I haven't been using phones … been using PCs."*
> ***Student CB:*** *"It's made things easier and faster e.g. mobile banking."*
> ***Student CC:*** *"I use PC for practical sessions."*

Demographics: age, gender and discipline

As mentioned earlier, there were also differences on the group demographics. For example, in the Computing group, there were more students belonging to the millennial age (semester A: 94%; semester B: 90%) than in the non-Computing group; 57% in semester A and 66% in semester B. Gender-wise, there seem to be no standard pattern. There were 74% of females in the non-Computing group compared to on 25% of all respondents in the Computing group.

In the focus group study, there was only one male among the Modern Languages (non-Computing) students. The Computing group had even numbers (4 of each) in the first semester; 6 females, 4 males in the second. This may indicate gender is more likely related to the profession i.e. in the Computing group, Computer Systems and Networks undergraduates in the freshers survey and Computing pre-service tutors in the second. Although it may be concluded the Computing group preferred PCs and laptops as a result of their discipline, which involves programming and familiarisation with PC architecture as part of the module specification, it was not clear in the review of this study if age and gender played a part in preferences.

In general, it would appear the Computing pre-service tutor group seem more inclined to use MDTs and other technologies readily in spite of the ban imposed on mobile devices. More than half of them facilitated at least one session using MDT while only three students did in the Modern Languages group. One of them suggested it may be because he was from a "*programming background*". However, those on the Modern Languages group make up for this drawback in that they seem more inclined to accept responsibility for their continuing development in terms of technology integration in learning. One student said:

> *"I think it would have helped but I got along ok without it. I just got the students to show me or maybe another teacher. I think we need to be proactive in doing it or ourselves asking for help but we also need to be pushed and encouraged to do that."*

Another fundamental difference between academics and students may lie in the notion discussed at the beginning of Section 7.3.3 in terms of students becoming change agents. It may be interesting to note while academics may see students as possible change agents or envisage this for them, the students themselves are not quite sure this is a role they want to take on. This was clear when the question was put to the pre-service tutor students in the final focus group discussion.

Most of the students seem unenthusiastic about bucking the trend in their schools and changing the status quo. Only two among the Modern Languages group indicate they may. One of the two said: "*I don't know because I don't know where I am going yet and how all the departments are. If I can be a little bit more comfortable then yes I would share good practise.*"

6.5. Discussions and conclusion on findings

Several patterns emerged from the findings presented in this chapter. The initial comparison study among some academics, students as well as those in the role of learning support and governance was useful in pinpointing further lines of enquiry explored in subsequent studies. Interviews with academics and those in the role of learning support and governance; in addition to the surveys, focus groups and observations among students conducted in mixed inquiry methods mode involving both quantitative and qualitative techniques revealed yet more dimensions within the domain.

Some of these findings may be summarised in relation to HE practitioners and stakeholders as follows:

- **HE governance:** Tablet issue to new students, making the wireless infrastructure more robust and BYOD scheme are good baseline starting points that must be further built upon and developed. Specific policies outlining expectations regarding MDT's uses in learning and teaching and encouraging an MDT-friendly environment is sorely required for the progress of ML. Staff development training and incentives are also necessary.
- **Academics in HE:** While academics facilitators may not actively facilitate the use of MDTs, fostering an MDT-friendly environment in their practice may be useful and perhaps even crucial to achieving learning objectives in many cases; given some students will likely use MDTs regardless. Guiding and providing leadership to students on effective uses to support learning may also reduce distractive uses during session. For example, an app suggestion to psychology students encouraged the students to download the app and use it to support their informal learning and reinforce topics introduced during sessions.
- **Learning support:** Researching and promoting MDTs' effective use during staff development trainings could create more awareness about potential benefits among academic users. This may also help reduce the overwhelming feeling relating to the number of technological options available.
- **Students:** Student seem to take some of the treatments they get through usage in stride, perhaps as a result of guilt or other reasons. However, as one of the students stated: "*We pay £9,000 per year, so we should*

get the best." Therefore, it may be useful to educate them on improper use and ensure they are clear on what is acceptable more in sessions. The students consulted all admit they have no idea if there were any institution-wide policies regarding MDT use in their sessions.

As theorised at the onset of the research, these findings reveal a lot more is needed to move the agenda forward for ML and the sustained integration of MDT in learning and teaching. Perhaps more importantly and regardless of whatever opinion may be held on the subject, it is also clear doing nothing may not be an option for any reputable HEI. Ongoing support for both academics and students is a key finding which also supported what was found in literature. For example, the pre-service tutor students were more or less 'encouraged' to use MDTs and / or new technologies in their practice without opportunities for practical use and it was clear the students unanimously felt dissatisfied: "*My computer survey that I filled in beginning of this week, I put poor for technology. I was very honest about it because I don't feel that I was trained.*"

Mentoring in terms of technological use, induction and ongoing support at their respective placement schools were also found to be less than efficient. It is interesting to note some of the academic tutors on PGCE programme feel enough is already being done: "*I would say more and more we are providing adequate support in that area*". This may indicate a mis-match as all the students feel they were not supported enough; although one or two admit they should perhaps take responsibility for own continuing professional development in that area.

The varying conditions in the pre-service tutors' respective placement practice schools may also create some inequality to some extent. The students were assessed on technological integration in their practice. However, as a result of the varying conditions regarding infrastructures and support, some students will undoubtedly fair better than others based on their experience. This inequality may need to be addressed within the programme structure to ensure pre-service tutors are thoroughly equipped to use technology in their practice after they graduate. Also, the ban imposed on mobile phones which is still firmly in place in schools, while not particularly seen as a barrier that cannot be overcome or violated by the students, may create potential problems for MDT integration in future, limiting what they may be able to offer their students.

The general conclusion from all participants to the review of this thesis indicate popularity of MDT use among students is growing, supporting findings from secondary data presented in Section 1.3.2. This is likely to continue as HEIs continue to support BYOD schemes and start issuing tablets to students. It is anticipated more and more students will feel it is a 'right' to use MDTs within their learning whether facilitated or not. An academic remarked:

> *"In theory, technology should be in schools enhancing / enriching learning and the learning that are taking place in institutions should be suitable for future technological and economical needs and things like that. And although that's not the core of subjects in HE, I don't think it should be in question and there should be other issues surrounding the broader line of the curriculum that people should be having access to."*

The passage of time and advances in MDTs have eradicated some issues such as small device screens, short battery power duration, device and running costs etc. Some issues relating to multiple networks and platforms exist still, and internet connection and wireless availability is still less than robust around some campuses. The situation regarding these particular issues are however improving rapidly as new standards and innovative technologies are created, and wireless and network infrastructures made more robust. It is anticipated these issues will also be eradicated in time.

Issues relating to classroom management, or more specifically, perceptions or beliefs about classroom management are however still very much unresolved. This research found some of these issues may be assumed rather than real but still present. Some are beginning to start thinking there are ways around these issues but many more are still using them as reasons not to engage. This research also found issuing tablets or devices to students is seen as a good start by many academics in spite of the absence of plans or formal guidelines on learning use.

However, this does not bode well for their effective use in learning processes.

One participant suggested they may end up categorised as disruptive, as a result of possible theft of devices or students forgetting to bring them to sessions, unless they are more seamlessly integrated into learning and teaching. BYOD schemes are also lauded by many participants but they also suggest effectiveness need to be monitored more strategically. Staff development training should be provided for IT service as well as teaching and learning staff to support students in both schemes.

Chapter 7

Technology is enabling our need to be mobile. We want to ensure that learning matches our lifestyle.

~ Tony Bingham, American Society for Training Development (ASTD)

Essentially, all models are wrong … the practical question is how wrong do they have to be to not be useful.

~ George E P Box (Source: http://en.wikiquote.org/wiki/George_E._P._Box)

The *ideal* 'mobility in learning' ecosystem

7.1. Modelling *mobility* into *learning*

A snapshot of findings and results from empirical studies have been outlined in Chapters 5 and 6, and the changing demographical profiles of students as, not only the main service users of Higher Education (HE) but also value-added 'products' of the system, was also considered in Chapter 5. If learning is expected, conceivably, to change learners' behaviour permanently, HE is part of the ecosystem designed to effect these changes; tasked with turning 'unskilled' individuals into 'matured' and 'skilled' professionals contributing to the society.

This chapter presents requirement goal models for ML system in an HE environment, derived from a compilation of the empirical findings from stakeholders to the review of this thesis and other sources. The models show conceptual representations for 'system-as-is' and 'system-to-be' while illustrating how goals for ML can be aligned with institutional policies and strategies. This chapter also introduces and illustrates the use of Tropos methodology techniques, based on the *i** modelling framework developed by Eric Yu for RE and employed in Agent Oriented Software Engineering (AOSE) discipline.

The *i** modelling notations of actors, goals, *softgoals*, plans, resources, and dependencies can be used to analyse relationships and role assignations within ML ecosystem. In the final chapter of this thesis, the ideas consolidated in these models will be further explored in a theoretical discourse on co-evolution relationship between MDT and educational practices. The chapter will consider likely impact of such a relationship on the future of ML. This will form the theoretical and empirical basis on which the future of ML will be considered, along with recommendations for sustained integration of MDT in educational practices.

7.2. The human-factor of ML systems

One of the key areas of RE or any systems requirement specification process is establishing roles within the system and allocating responsibilities. Although this is a crucial part, it is sometimes overlooked or given less attention than it deserves, according to Elgebeely (2012). Illustrating the problem with a 3-tiered pyramid locating ‘tools’ at its apex, ‘people’ at the base and ‘processes’ in the middle, Elgebeely (2012) argue human factor in software development often fail to get enough attention. Elgebeely (2012) advocates turning the pyramid on its head and putting the people first.

From scoping to implementation and beyond, a common thread woven through software development life-cycle is the human agents. Ignoring this aspect is assumed to be one of the causes of poor identification or specification of user needs, inadequate testing or bug detection, unrealistic goals, badly defined requirements, stakeholder politics etc.; a subset of factors commonly listed as causes of failure in software projects (Charette, 2005; Elgebeely, 2012).

Opinions of some of the stakeholders in HEIs have been elicited for the review of this thesis regarding ML and the integration of MDT in learning and teaching. Recognising many of them are potential implementers and executors of processes within systems in HEIs, perhaps including ML systems, it was important to gain a better understanding of the findings highlighted in Chapter 6. Therefore, while ML may not be a typical software system, it is recognised understanding the actions of individual actors within the system will be essential. This is not only for the purpose of understanding the relationships between the actors themselves, but also identifying the likely impact of their actions / inactions on institutional goals and goals for ML.

One of the strengths of RE is its ability to explore a system from stakeholder perspective and establish a set of requirements that has taken the human factor into consideration. These include techniques for negotiations and brainstorming as well as for conflict resolutions and requirement ranking for example; useful for handling complexities involved in accommodating different viewpoints, encouraging optimum buy-in as well as ongoing participation etc., within a system.

These techniques have been outlined briefly previously in Chapter 4 and mentioned in other sections. Some of them such as goal ranking and conflict resolution using trade-off analysis will be illustrated further in this chapter. Techniques from AOSE discipline will also be introduced and used in conjunction with other RE techniques, such as goal modelling, to present models for ML ecosystem.

7.2.1. Agent Oriented Software Engineering (AOSE)

AOSE has gained some grounds as a discipline over the last decade, not only "*as a design modelling tool*" but also "*as an interface to platforms which include specialised infrastructure support*" as well as "*interacting processes*". It is particularly useful for the exploration of "softw*are agents and multi-agent systems*" (AOSE, 2008). An agent has been described as an entity which is capable of running routine tasks to achieve specific goals within a system (Abbas, 2010). While such agents are typically computer programs performing functions within a software application or programming environment, system modellers may often depict human interactions as agents or actors within a system.

In this sense, an ML system may qualify as an agent-based one, and as a consequence, benefit from the application of Tropos methodology of AOSE discipline. It may be relevant to mention there are other AOSE methodologies like MESSAGE, MaSE, Prometheus and Gaia that may be potentially useful in similar circumstances. Tropos methodology was selected for the review of this thesis because of its foundation on Eric Yu's *i** modelling notations.

The *i** modelling notations are part of Eric Yu's framework specifying User Requirement Notation (URN) and incorporating Goal-Oriented Requirements Language (GRL) for RE (Yu, 2008). It has recognisable specifications for actors, goals and actor dependencies considered to be particularly relevant for the review of this thesis. Tropos methodology was also considered best in an evaluation review for "*adequacy and expressiveness*" (Abbas, 2010, pp. 393).

7.3. Overview of the Tropos methodology

Apart from providing notations for specifying actors, agents and dependencies, another advantage offered by Tropos methodology for the review of this thesis is the phased stages which include early and late requirements specification for a system. These are essential for the requirement engineering of ML system because as well as providing means by which elicited goals, activities and requirements of a system may be classified, it also allows for further incremental refinement and identification of goals, *softgoals*, resources, actors, agents and dependencies. In addition, modelling may be constructed in the context of the organisation within which the system operates (Giorgini et al, 2004).

Therefore, the resulting models captures *WHAT* the system does and is all about, *HOW* these activities as well as responsibilities are performed or executed and *WHY* a particular analysis, artefact or the system itself may be necessary or implemented (Lamsweerde, 2001, pp. 3). Finally, the simplicity of the common terms and logical notations employed in Tropos methodology was found to be of great advantage for clarity, while also providing traceability through multiple phases i.e. allowing for "*artifacts produced during later phases*" to refer "*back to artifacts or requirements produced earlier*" (Bresciani & Sannicolò, 2003, pp. 3).

Thus, Tropos methodology covers every aspect of a system development in five phases as follows:

- **Early requirements:** In this an understanding is gained about the 'system-as-is' through categorisation, analysis and modelling of requirements and goals from the elicitation process, and from the organisational model. Actor and goal models are used to present the current state of the system along with tasks and dependencies.
- **Late requirements:** The 'system-to-be' is specified during this stage, defining the functional and non-functional requirements of the system to be. Actors and goals are also shown, along with dependencies as well as their functions and relevance within the system. An ongoing system review plan is also created for the system-to-be.
- **Architectural design:** A global architectural design is specified and the system-to-be decomposed to show sub-systems, interconnections as well as overall dependencies.
- **Detailed design:** Each of the sub-systems in the architectural design is defined along with agents, goals and dependencies as well as a specifications for the inputs and outputs of the system, including control points and other relevant requirements.

- **Implementation:** The system-to-be is implemented and ongoing system review plan initiated.

Source: Giorgini et al (2004)

There are a number of open source tools developed for use with Tropos methodology, including the OpenOME (Open Organization Modelling Environment) tool and the *i** framework syntax used in the review of this thesis. In the following sections, activities within some of these stages will be explored and used to generate graphical models for ML system-as-is and system-to-be along with some architectural models using goal decomposition techniques of Tropos.

7.3.1. Using the OpenOME tool

The OpenOME is particularly useful for modelling goal and agent oriented systems, providing an environment with user interface, a drawing palette containing symbols and notations for goal modelling. OpenOME is a Java Eclipse RCP (Rich Client Platform) with a much simpler user interface and support for Windows, Mac OS X and Linux platforms.

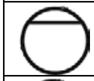
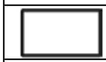
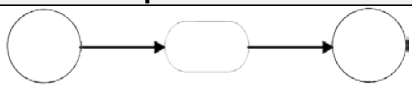
7.3.2. The *i** framework notations

OpenOME uses the *i** framework syntax notation for creating goal model diagrams. The framework has specifications for several notations which has been modified for goal modelling in Tropos methodology. Table 7.1 provides some basic information on the common notations specified by the *i** framework.

Actors, agents, positions and roles

As outlined in Table 7.1, actors carry out actions that will achieve a specified goal. An actor may be a single individual or a unit or department with specific functions or activities e.g. a person in ‘academic tutor’ role or student enrolment department. Agents are actors physically manifested within a system; human or artificial intelligent i.e. programmed agent. These *play* roles and *occupy* positions within a model as sub-units of the actor (see Table 7.2). The Positions they occupy are assumed or said to *cover* roles (Kolp et al, 2003).

Table 7.1: The *i framework syntax notations**

Legend	Description
	**Actor:** Carries out actions to achieve a goal. May be a single individual or a unit which carries out specific actions to realise specified goal.
	**Agent:** *Actors* that are physically manifested e.g. human or an artificial intelligent agent. *Agents* play roles and occupy positions.
	**Role:** played by *agents*.
	**Position:** cover *roles*.
	**Hardgoal:** Specific goals / functional specifications for the system e.g. '*passing the assessment examination*'.
	**Softgoal:** Non-functional specification; a measure of how well functions within the system have been achieved; but they may be subjective and non-achievable e.g. '*passing the assessment examination with distinction*'.
	**Resource:** provided by actors in a dependency relationship.
	**Task:** represents activities performed by a *dependee*.
Dependencies	
 Depender → dependum → dependee	
A dependency describes an "agreement" (called *dependum*) between two actors: the *depender* and the *dependee*. The depender is the depending actor, and the dependee, the actor who is depended upon. The type of the dependency describes the nature of the agreement.	

Dependencies, goals, softgoals, plans and resources

Association links show dependencies and relationships between actors. A *depender* is actor who depends on another actor in a relationship. *Dependee* is the actor who is depended upon while *dependum* is the agreement or element between actors which can be either goals, *softgoals*, *tasks* or *resources*. The relationship is represented in the form: *depender → dependum → dependee* (see Table 7.1).

Goals are *functional requirements* with responsibilities for actor depender and dependee. Soft goal (softgoal) are *non-functional requirements* or goals that may be subjective or incapable of being satisfied precisely. Tasks represent an activity to be performed by the dependee and resource is provided by a dependee to the depender. See Table 7.1 for relevant notations.

The organisation

As suggested earlier, Tropos methodology allows for systems to be specified within organisational contexts. Kolp et al (2003) suggest Mintzberg (1979)'s structure-in-5 organisational model. This is based on the understanding that a system does not exist in a vacuum and are operated within an organisation. Defining a system in organisational context makes it possible to reflect the actor / agent positions within the system as well as roles, positions and the tasks they perform. It also makes it possible to align the strategic goals of the organisation with actors, agents, roles, positions and tasks; reflecting the dependency relationships.

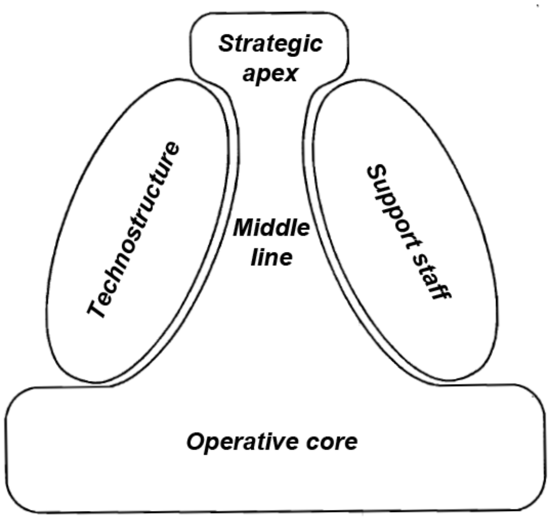


Figure 7.1: Mintzberg's Structure-in-5 organisational model (Mintzberg, 1979, pp. 33)

As may be appreciated, higher educational organisations are complex environments. Mintzberg (1979) suggest the more complex an organisation is, the more necessary are mechanisms required for coordination and supervision. The original structure-in-5 organisation model as proposed by Mintzberg (1979) is shown in Figure 7.1. The author described the model as "*the glue of structure … that hold organisations together*" (pp. 9). As shown, the model has *strategic apex* at the top and *operational core* at the base with *technostructure*, *middle line* and *support* linking both in the middle.

Table 7.2 outlines representative units and sub-units in a structure-in-5 organisational model for HEI. These are further illustrated in Figure 7.3 to indicate how the agents or representative sub-units (Table 7.2, column 3) may be located within a Structure-in-5 model for HEI (Figure 7.2). Note the corresponding colours used for each component in both Figures 7.1 and 7.2. (For example, the colour 'green' is used for "Governance" in Figure 7.1. The same colour is used for the likely agents within "Strategic apex" in Figure 7.2, and as shown in Table 7.2, column 3.)

It may be useful to mention the units and sub-units (Table 7.2, column 3) are representative only and each unit / sub-unit may be reflected or allocated differently in HEIs. The allocations in Figure 7.1 and 7.2 are however useful for illustrating some of the core functions within HEIs using the *i** notations for actors, hardgoals, softgoals, resources as well as dependencies in depender → dependum → dependee format. They will be used in the models presented in the subsequent sections of this chapter. Figures 7.2 and 7.3 are both based on Structure-in-5 organisational model proposed in Mintzberg (1979, pp. 33) and further enhanced for a food production company in Kolp et al (2003, pp. 5-7).

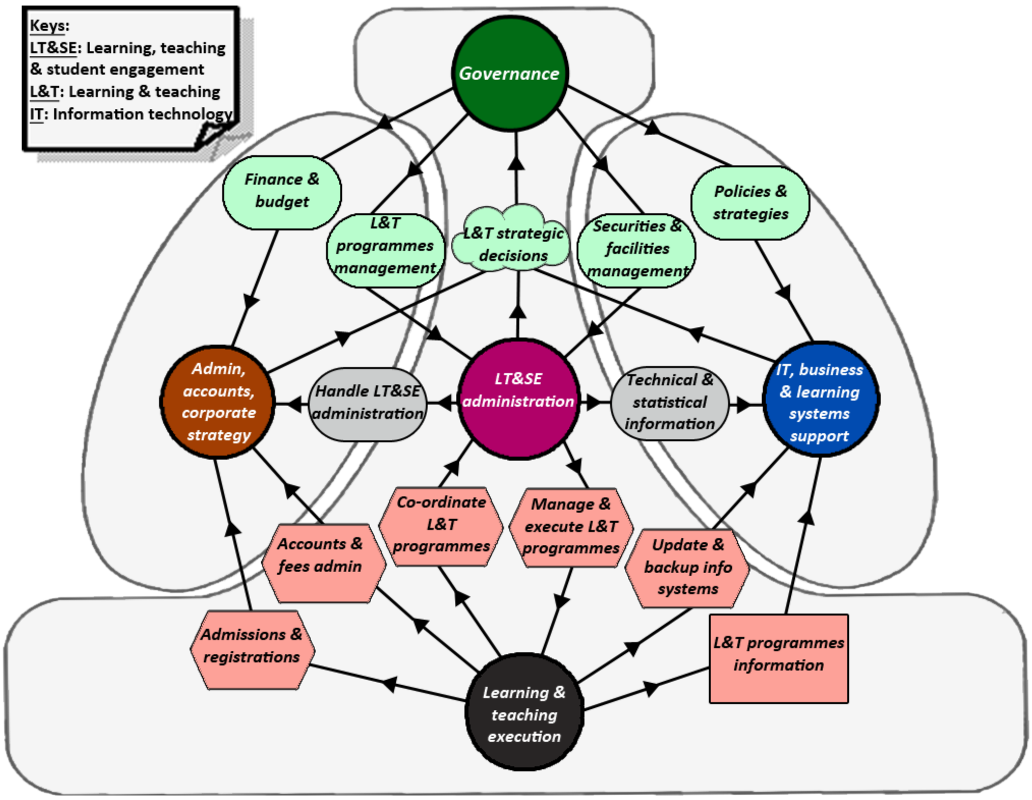


Figure 7.2: Structure-in-5 model for HEI, based on Mintzberg's Structure-in-5 model

The *i** notations for specifying *depender* → *dependum* → *dependee* can be used to link goals, tasks, softgoals and the relationship existing between the positions. For example, the strategic apex is the *depender* for technostructure, middle line and support; all three are *dependees* to strategic apex, and the *dependum* should be goals for the organisation or section or group.

Technostructure, middle line and support have a softgoal dependency while technostructure, middle line and support have goal (hardgoal) dependencies between them (Kolp et al, 2003). Middle line and operative core can only have task dependencies between them with middle line as *depender* or *dependee* and operative core as *dependee* or *depender* as the case may be.

Table 7.2: Actors and agents in Structure-in-5 model for HEI

Structure-in-5 components	Organisational units (actors)	Representative sub-units (agents)
Strategic apex	The Board & Vice-Chancellor's Group (VCG)	Vice-Chancellor and Chief Executive
		Deputy / Pro Vice-Chancellor(s)
		Director of Financial Services
		Head of Legal and Governance Service
Technostructure	Learning, Teaching & Student Engagement (LT&SE) administration	Corporate communications
		Marketing & student recruitment
		Financial services management
		HR management
		Other admin (Facilities, finance / purchasing etc)
Middle line	Administration, accounts & corporate strategy	Schools / Academic faculties / Academic Registry
		Academic partnerships
		Research, innovation and enterprise
		Learning, teaching & student engagement
		Employability & student support
Support	IT, business & learning systems support	Information Technology (IT)
		Business Information Systems (BIS)
		Learning systems
Operative core	Learning & Teaching Execution (L&TE - LTE)	Director of Learning & Teaching
		School / Faculty Heads & Executive Officers
		Programme Leader
		Academics / Instructors
		Library & Learning Support
		Student Representatives

7.4. Goals for ML ecosystem

To illustrate how Tropos methodology may be used to model system-as-is and system-to-be, extracts from the strategic policies, elicited requirements from participants in the review of this thesis and quality dimensions an HEI may be aiming towards will be used to derive a set of goals (functional requirements or *hardgoals*), soft goals (non-functional requirements or *softgoals*) and tasks within the ML system. The following goals may be identified from strategies proposed in a white paper by a UK HEI, first presented in Section 4.2.2:

- Provision for digital ML and spaces for both collaborative and reflective study.
- Provision of transformational opportunities.
- Removal of barriers to progression & facilitation of competitiveness in employment.
- Development of flexible offers for a more distributed, mobile & time-conscious market.
- Exploration of a range of collaborative / high-quality partnerships.
- Delivery of programmes at times and in places which suit the learner.
- Achieve the objectives without investing significant amounts of capital.

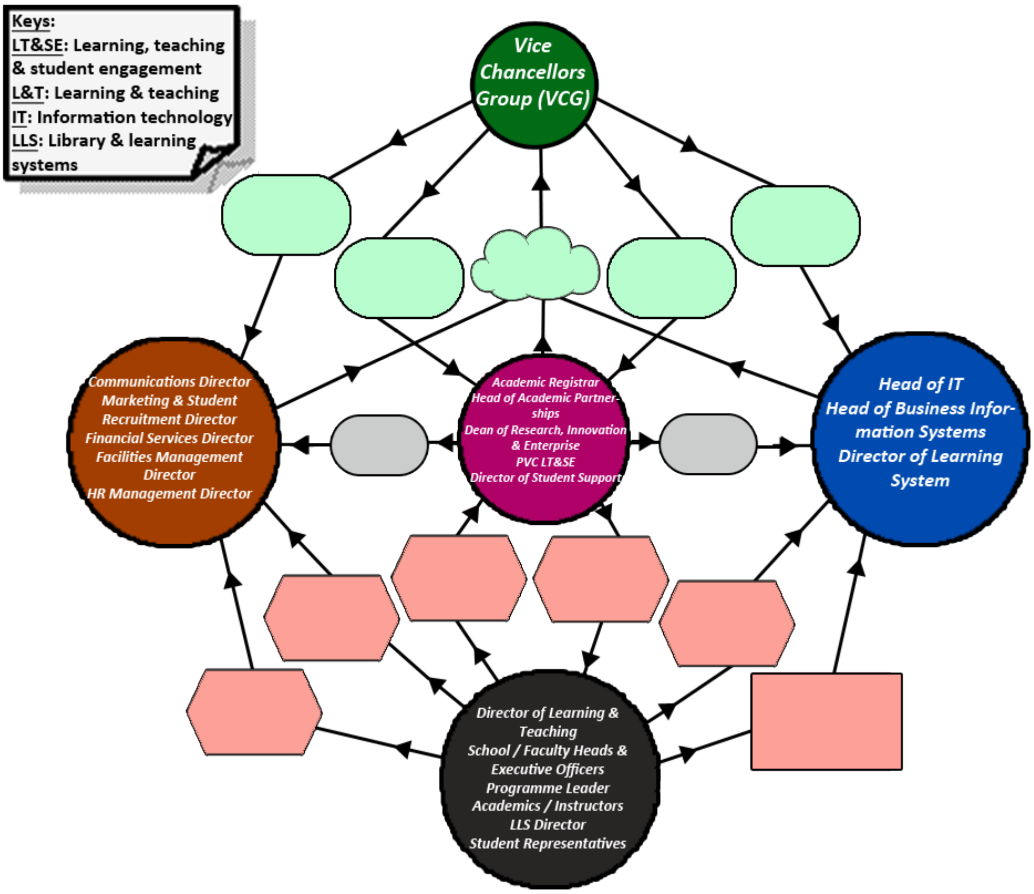


Figure 7.3: Representative roles in HEI's structure-in-5 model

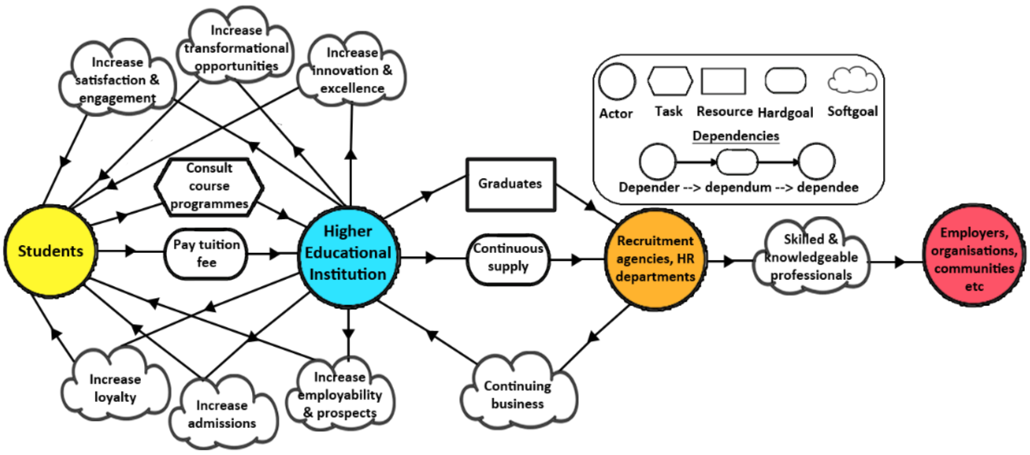


Figure 7.4: Strategic dependency model for the operative core (Learning and Teaching Execution – LT&E) in HEI

In a simple introduction to Tropos methodology, Figure 7.4 is a strategic dependency model derived using the extrapolated policies first presented in Section 4.2.2, in the review of this thesis. Figure 7.4 is based on a dependency model for a media shop, developed by Giorgini et al (2004, pp. 4). It shows "*strategic dependencies*" within the *operative core*: the Learning and Teaching Execution – LT&E (see Figures 7.2) which will be further developed to include actors and agents later in this Chapter. Other HEIs may have different strategic policies, with variations of some of these objectives expressed in one form or the other. For example, some of the listed objectives were also identifiable from the teaching and learning or e-learning strategies of University College London (2012), University of Kent (2014) and University of Warwick (2014). Invariably, these form part of the requirements and goals for the organisation.

Goals from elicited requirements

The elicitation process conducted for the review of this thesis provided a rich source for deriving goals and requirements for ML system. A full list can be found in Table 1 (Appendix 4), mapped to the categories in ML evaluation criteria and indicators table specified in Section 2.3.5 (Table 2.6). Goals and requirements from elicitation are often expressed in soft goal terms or as desirable requirements. The categorisation for ML evaluation indicators proposed in Section 2.3.5 (Table 2.6) will be used as top-level goal categories for the goals / requirements derived next to provide a link to evaluation indicators, and potentially, a way to measure success or failure.

- Mobile Device Technologies (MDTs) / infrastructures – Consideration for access, competencies & preferences for all users (staff, students and other stakeholders).
- MDT users: Staff (instructors and support staff) and students' - Needs requirement analysis.
- Instructional design in MDT-friendly environment / student-centered learning.
- Content & curriculum in MDT-friendly environment / student-centered learning.
- The learning space for MDT-friendly environment / student-centered learning.
- Institution / organisation's responsibilities - Integration, sustainability and governance.
- Risk analysis and management, including impact on users.

While it was possible to derive goals and requirements from strategic policies and the elicitation process, there are potential conflicts yet to be resolved. For example, it may be important for educators that "*'tick-box' / exam result agenda*" is avoided but students may feel differently and device manufacturers may not care either way. Similarly, while the governance may want "*innovation & infrastructure provision without excessive capital outlay*", educators and students may be less than impressed (Table 1, Appendix 4). The goals should also be categorised and ranked to determine prioritisation.

Table 7.3: A subset of the trade-off analysis for ML system

Goals		Functional requirements / stakeholders					
		Students	Educators	Learning support	Governance	Government / global educational policies / acts	Device manufacturers
G050	Tick-box' / exam result agenda avoidance	✓	✓✓✓	✓	--	--	-
G070	High-calibre / renowned academics engagement with undergraduates	✓✓✓	--	-	✓✓	✓	-
G070	Transformational opportunities provision	✓✓✓	✓✓✓	✓	✓✓	✓✓✓	✓
G080	Learning platform easy to use, available 24/7, trusted, robust and environment	✓✓✓	✓✓✓	✓✓✓	✓✓	-	✓✓✓
G090	Enhanced, rich, enjoyable, engaging learning experience the norm	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	-
G090	Technology use only for educational purposes	--	✓	✓	--	-	--
G100	Immersion & dissemination of innovation	-	--	✓✓	✓✓✓	✓	-
G100	Financial performance element reduced	✓✓	✓✓✓	✓✓	--	-	-
G110	Fitness for purpose ensured in technology use	✓	✓✓✓	✓✓✓	✓✓	✓	-
G110	Technological tools are accessible & benefits to learning & teaching translated	✓✓	✓✓✓	✓✓✓	✓✓	-	✓✓
G120	Buy-in from staff & students in a downwards / upwards leadership approach	✓✓✓	✓✓✓	✓✓✓	--	✓	-
G120	Pilot / testing of initiatives thorough	-	✓✓✓	✓✓	✓✓	-	✓✓
G120	Learning apps, testing for relevance before use	✓✓	✓✓✓	✓✓✓	✓✓	-	-
G120	Beta / gamma testing of new technology for network interoperability	-	✓✓✓	✓✓	✓✓	-	✓✓
G140	Learning spaces, social & robust	✓✓✓	-	✓✓	✓✓✓	-	✓
G140	Learning spaces, mobile for collaboration & reflection	✓✓✓	✓✓✓	✓✓	✓✓	-	✓✓✓

Key:

Ticks (✓): Prioritisation for stakeholder group

Double dash (--): Disapproval, conflict or concerns

Dash (-): Neutral stand

Plus (+): Indicate relationship between goals and NFRs

Conflict resolution process can be complex, sometimes requiring several techniques are employed including ranking (Berenbach et al, 2009; Sutcliffe, 2013). It may also be necessary to infer priorities and categorisation based on elicited comments from stakeholders and prioritise these as necessary, especially when it is not possible to employ some of the other methods. This technique have been used to create a trade-off analysis for the ML system, modelled in Figures 7.5 and 7.6. A subset of the table is shown in Table 7.3 showing stakeholder priorities and likely positions on each issue. (The entire table can be seen in Table 1, Appendix 12.)

The items in Table 7.3 have been derived and ranked according to elicited stakeholder requirements and from policy statements from an HEI's white paper for ML system (see Table 1, Appendix 4). In Table 7.3, strengths or level of importance indicating popularity of an item among stakeholder groups have been shown by doubling or tripling of ticks (✓) and pluses (+). This method is also used to reflect inference of perception on the item through observation and / or other data gathering methods employed in the review of this thesis.

7.4.1. Quality dimensions and Quality Attribute Requirements (QARs)

Another method for ranking goals and requirements is through the use of quality attributes or dimensions the organisation may consider important. Quality dimensions can sometimes be derived from an amalgamation of a set of template sets to reflect the organisation's ethos.   Therefore, elicited goals and requirements for ML system are not only associated with strategic policies but also with quality dimension(s). This reinforces the notion proposed in this chapter and throughout the review of this thesis, suggesting when ML system goals are not satisfied, achieving strategic objectives and quality dimensions of the institution will be difficult if not impossible.

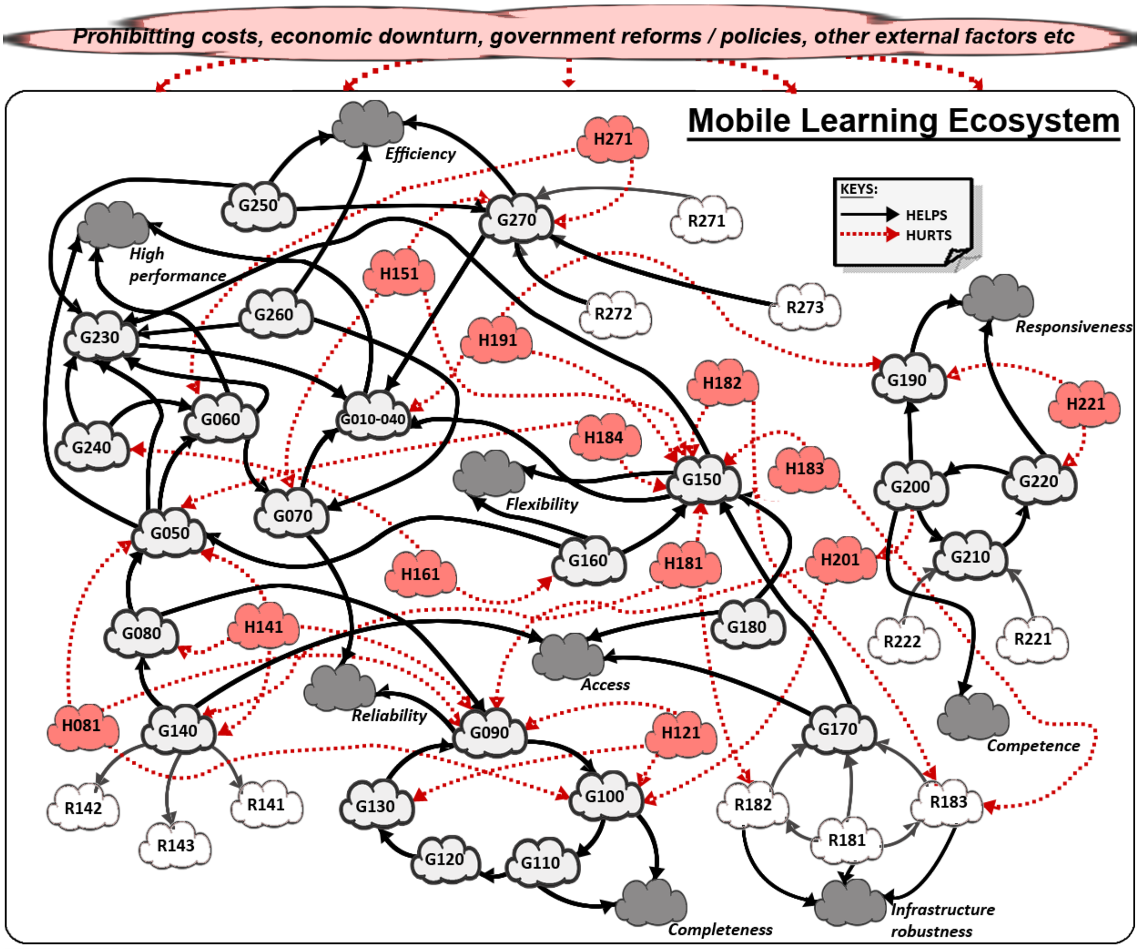
Grönroos (1990; cited in Owlia and Aspinwall, 1996) offered two similar sets of quality dimensions for HE: *technical* and *functional* or *corporate image* qualities. While technical qualities can be measured, functional or corporate image qualities are often dependent on user interactions and therefore subjective. Another likely source for quality dimension may be those proposed for *physical*, *interactive* or *corporate* qualities by Lehtinen & Lehtinen (1991; cited in Owlia & Aspinwall, 1996). Others categorised qualities into *presages*, *processes* and *outcomes*, *services* and *products* etc. (Owlia & Aspinwall, 1996; Gibbs, 2010).

Table 7.4: Quality dimensions for products and services

Attributes / dimensions	Definition & characteristics
Reliability	The degree to which education is correct, accurate, up to date, how well an HEI keeps its promises, the degree of consistency / uniformity in educational processes (teaching)
Responsiveness	Willingness and readiness of (academic) staff to help students, giving personal attention.
Understanding customers	Understanding students and their needs
Access	The extent to which staff are available for guidance and advice
Competence	Theoretical, practical and up-to-date knowledge of staff as well as presentation skills Teaching expertise, communication
Courtesy	Emotive and positive attitude towards students
Communication	How well lecturers and students communicate
Credibility	The degree of trustworthiness of the institution
Security	Confidentiality of information
Tangibles	State, sufficiency and availability of modern up-to-date equipment and facilities, ease of access, visually appealing environment, support services (e.g. accommodation, sports etc.)
Performance	Delivery / primary knowledge / skills required for students, sequencing, timeliness, consistency, fairness of examinations etc
Completeness	Supplementary knowledge and skills, use of technology, relevance of curriculum to the future jobs of students, completeness, use of innovative technologies, communication skills, team working, flexibility of knowledge being cross-disciplinary
Flexibility	The degree to which knowledge / skills learned are applicable to other fields
Redress / Maintainability	How well an institution handles customer complaints and solves problems
Correctness	The extent to which a programme / course complies with the specified requirements
Efficiency	The extent to which knowledge / skills learned are applicable to the future career of graduates

Table 7.4 is a list of some of the quality dimensions that may be applicable in an HE setting for products and services (Owlia & Aspinwall, 1996; Gibbs, 2010). Quality dimensions / attributes are usually non-functional requirements or NFRs i.e. with goals that are subjective, difficult to describe or specify and sometimes passive. For example, in Table 7.4, *Courtesy* is defined as "*emotive and positive attitude towards students*". However, evidence for this quality can only be garnered over time and cannot be tested directly (Berenbach et al, 2009).

Quality dimensions can be used in trade-off analysis to rank goals and requirements among stakeholders (Table 1, Appendix 12). Pluses (+), indicate relationship between goals and NFRs (quality dimensions). As illustrated in the trade-off analysis table (Table 7.3), there may be some non-functional requirements excluded from Table 1 (Appendix 12), such as security, availability etc. Therefore, items included should not be considered an exhaustive list of qualities for ML systems.



KEYS FOR *SOFTGOALS*:

G040: Student satisfaction & engagement / loyalty / HEI reputation status
G050: High quality teaching & learning
G060: Student success rate higher than benchmark
G070: Transformational opportunities consistently prioritised as publicised
G080: High quality spaces for teaching & learning
H081: Teaching & learning opportunities limited to classroom / timetabled meetings
G090: Innovative & scholarly teaching & learning offerings as publicised
G100: Capability for innovation & commitment to excellence activities
G110: Regular ample opportunities for ideas incubator / brainstorming
G120: Time allowance for pilot testing of ideas & obtaining buy-in before launch
H121: Little / no opportunities for ideas brainstorming & pilot testing
G130: New innovations arising from regular review / evaluation of practices
G140: Highly customisable & scalable digital mobile learning spaces
R141: Engaging: collaboration; knowledge construction; learning immersion, reflection, interpretation, an
R142: Authentic: with opportunities for application of new knowledge to real world solutions
R143: Measurable: with continuous reflective evaluation of instructional design & delivery
H141: Restricted & limiting learning spaces
G150: Flexible options for a more distributed, mobile & time-conscious market
H151: Options restricted by curriculum / policy constraints
G160: Programmes delivered at times & places to suits learner
H161: Programmes in traditional / fixed timetabling structures devoid of flexibility & seamlessness
G170: Integrate innovative technology in learning & teaching
G180: Ongoing support for effective use of innovative technologies
R181: Deploy robust & innovative technological infrastructure & network platforms
R182: Seamless access to learning platforms across devices & networks
R183: Learning / content deployable on variety of devices, platforms, multiple operating systems etc.
H181: WiFi connectivity patchy or nonexistent
H182: Incompatible network platforms & environment
H183: Device (or BYOD) support haphazard or nonexistent
H184: Restricting learning content / platforms / systems
G190: Timely & anticipatory satisfaction of students' needs & requirements
H191: Needs & requirements not established or satisfied successfully in a timely or anticipatory manner
G200: High level of expertise / competencies among staff & students on effective use of innovative technologies
H201: Little / no competency training on effective use of technologies
G210: Quality innovative technology competency training
G220: Accurate data on students' needs
H221: Inaccurate / irrelevant / unreliable data on students' needs & requirements
R221: Adequate time allowed for needs satisfaction (staff & students)
R222: Adequate time allowed time for expertise / competencies development (staff & students)
G230: Barriers to progression removed
G240: High quality student centered teaching & learning
G250: High rate of learner achievement, development & growth
G260: High number of breakaway students (less dependent on structures – Engeström 1996) relative to current student population
G270: High employability & career prospects
H271: Little / no opportunities for application of new knowledge to real world solutions
R271: High number of student interactions with world communities building networks
R272: Competitiveness in employment
R273: Range of collaborative / high-quality partnerships

Figure 7.5: ML system-as-is goal model with quality dimensions

7.5. Modelling the 'system-as-is'

As outlined in previous sections within this chapter, items extracted from policies in an HEI's white paper and elicited requirements from stakeholder participants to the review of this thesis have been categorised and ranked (see full details in Table 1 & 2, Appendix 4 and Table 1, Appendix 12). This will eventually become part of the system-to-be, as illustrated in Figure 7.6.

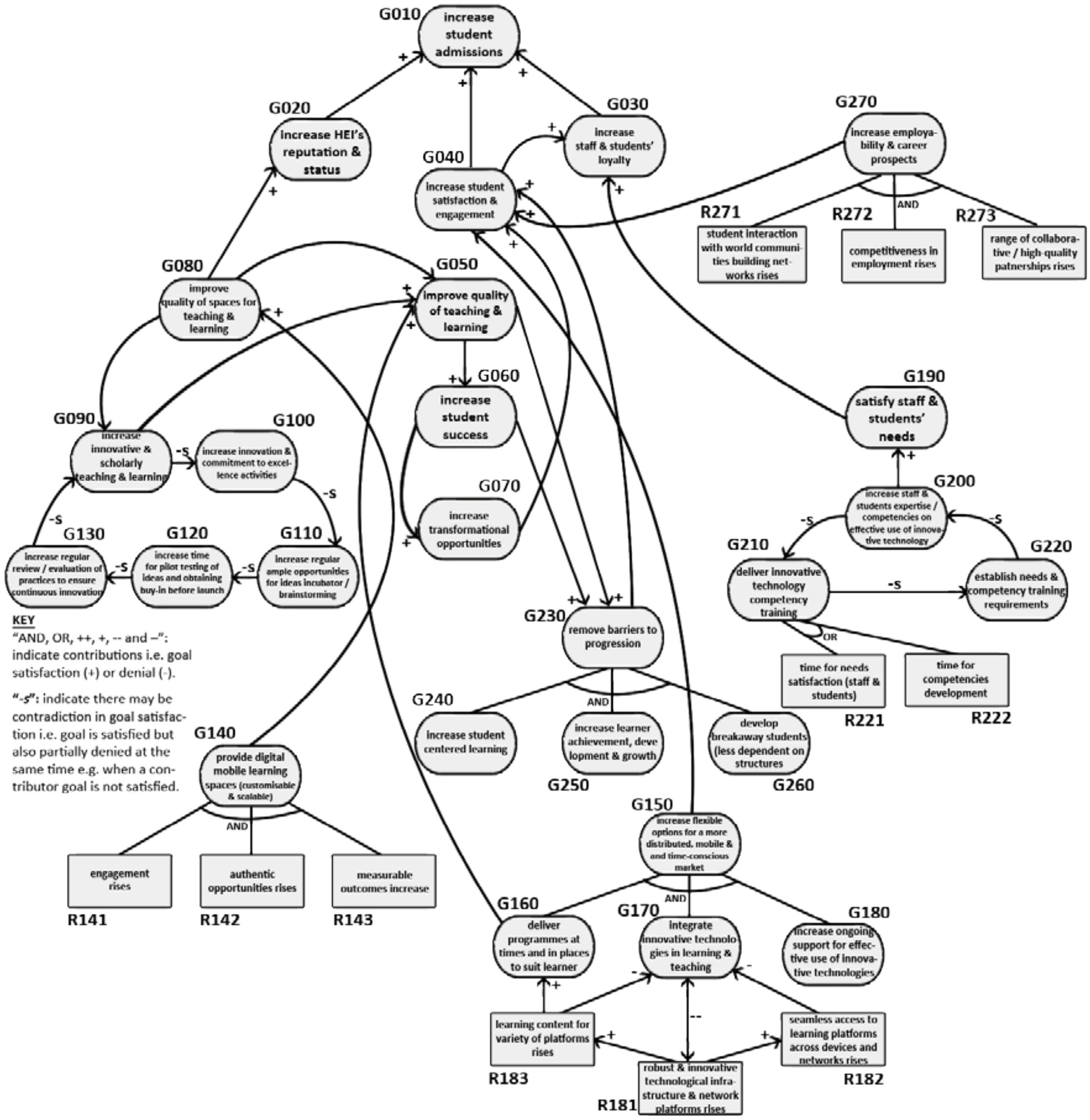


Figure 7.6: ML system-to-be goal model

Along with specifying goals and requirements, it was also possible to determine a set of attributes *hurt*ing (or capable of hurting) or *help*ing (or capable of helping) ML systems from an elicitation process. Resources required for the achievement of some of the goals can also be identified (see Table 2, Appendix 4). The relationship between these goals and requirements and the quality dimensions shown in Table 7.4 are reflected in the system-as-is model for ML system (Figure 7.5). Figure 7.5 is based on a partial goal model for a nuclear power plant simulator (Berenbach et al, 2009, pp. 51). See Table 2 (Appendix

4) for details of codes used in Figure 7.5 and 7.6.

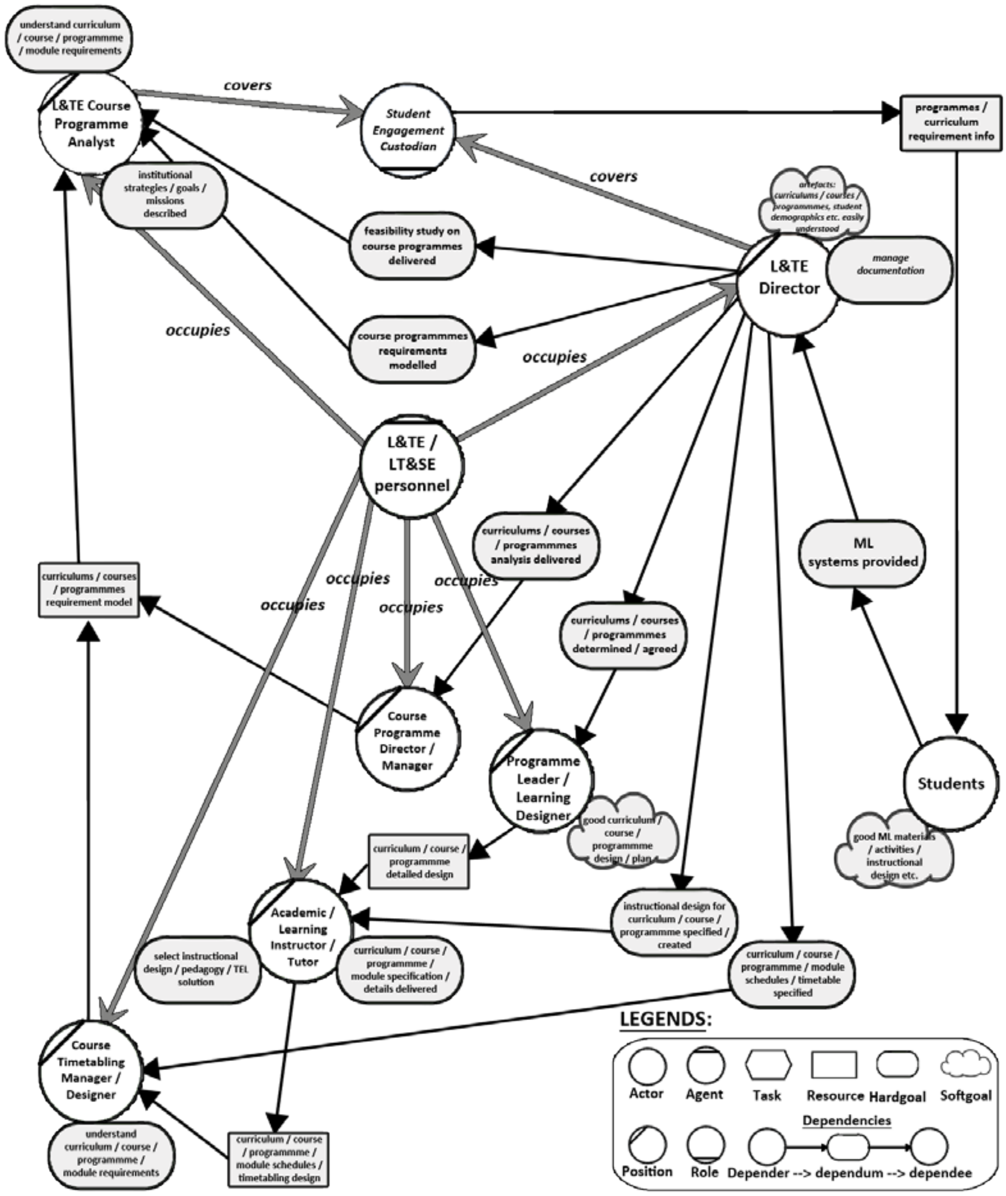


Figure 7.7: Actor diagram for Learning and Teaching Execution (LT&E)

7.6. Modelling the 'system-to-be'

In the system-to-be, qualitative relationships such as objectives and mission goals of an organisation tend to be expressed in subjective terms, and categorised as *softgoals* which makes it difficult to test achievement directly. Tropos methodology allows such objectives to be evaluated through the relationships between the *softgoals*; reflected using AND, OR, ++, +, -- and – operators (Kolp et al, 2003). This makes it possible to apply measurement metrics to *softgoals* and treat them like functional or hardgoal requirements.

To illustrate, in Figure 7.6, when R271 (student interactions with world communities building networks rises) ‘AND’ R272 (competitiveness in employment rises) ‘AND’ R273 (range of collaborative / high-quality partnerships rises), it is expected that goal G270 (increase employability & career prospects) will be satisfied. In contrast, either allowing R221 (time for needs satisfaction) ‘OR’ allowing R222 (time for competencies development) may achieve or satisfy the softgoal G210 (deliver innovative technology competency training). Figure 7.6 is based on a partial goal model for a US car manufacturer, developed by Giorgini et al (2004, pp. 16).

Using ‘AND’ and ‘OR’ also makes it easy to decompose the goals into architectural models for later analysis. Pluses (+) and minuses (-) indicate contribution in terms of goal satisfaction or denial or positive and negative contributions respectively. When doubled or tripled up, it indicates the strength of the contribution (Bresciani & Sannicolò, 2003; Giorgini et al, 2004). Satisfaction (S) can be full (++) or partial (+). Similarly, a softgoal may be fully or partially denied (D).

Satisfaction (S) and denial (D) are not mutually exclusive and can be contradictory, for example when a goal is *satisfied* but also partially *denied* at the same time (Kolp et al, 2003, pp. 14). This is represented using (-*S*, --*S*, +*D*, ++*D*). In Figure 7.6 for example, G220 can contribute to the satisfaction of G200; but just because G200 is satisfied doesn’t mean G220 has been satisfied, hence the –*S* contribution to G200 from G220 (Giorgini et al, 2004, pp. 17). See Table 2 (Appendix 4) for descriptions for the codes used in Figure 7.6.

7.6.1. Actor diagrams and goal decomposition

The system-to-be goal model in Figure 7.6 only shows relationship between the goals for ML system, without specifying stakeholders (actors and agents). As defined previously in this chapter, actors represent individuals or units while agents are sub-units of actors. Specifying dependencies and other aspect of the relationship between actors (units) and agents (sub-units) is crucial for establishing responsibilities and evaluating effectiveness.

An actor diagram for the *middle line*: Learning Teaching & Student Engagement – LT&SE, and the *operative core*: Learning and Teaching Execution – LT&E (see Figures 7.2 and 7.3), can be seen in Figure 7.7. Agents in both of these sections need to work together to *Co-ordinate / Manage & execute L&T (Learning and Teaching) programmes*. Figure 7.7 illustrates how this relationship may operate within an ML system; based on actor diagram specifying the stakeholders of the Tropos tool project, derived by Bresciani & Sannicolò (2003, pp. 6).

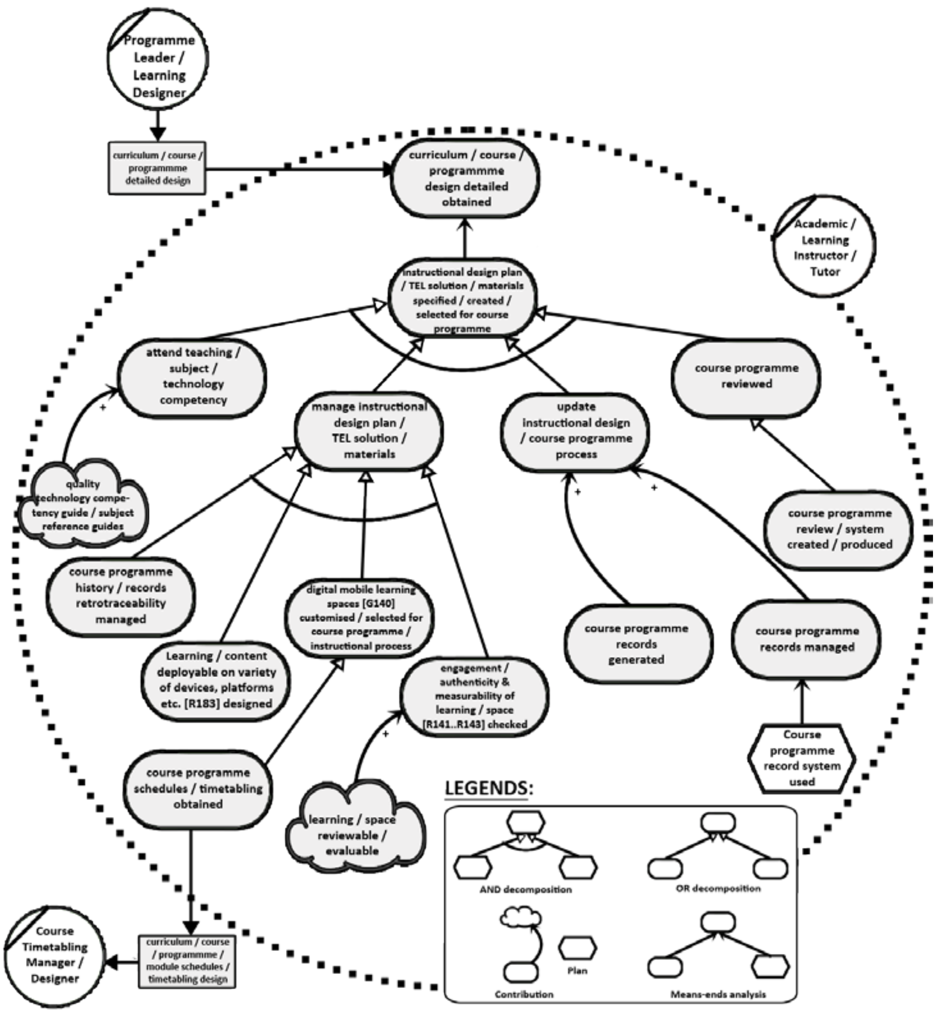


Figure 7.8: Means-ends goal decomposition for LT&E from the perspective of the Academic / Learning Instructor / Tutor

In the model, L&TE personnel is an actor agent who may occupy the positions of any of the following: L&TE Course Programme Analyst, L&TE Director, Course Programme Director / Manager, Course Timetabling Manager / Designer, Curriculum / Course / Programme Designer and Academics / Learning Designer. Also, each position may also cover different roles, one of which is represented by the Student Engagement Custodian. Hardgoals and softgoals dependencies are also shown (see Figure 7.7).

Further decomposition is necessary to produce architectural and detailed design models for system implementation. Tropos allows for detailed design models to be provided for each goal and each actor within the system and decomposition may start from the goal model and / or from the actor diagram. For example, a means-end analysis is shown in Figure 7.8 where the goal "*Flexible options for a more distributed, mobile & time-conscious market*" – G150 have been decomposed to show how this may operate from the perspective of the *Academic / Learning Instructor / Tutor*.

Figure 7.8 is based on goal analysis of the Tropos tool project, derived by Bresciani & Sannicolò (2003, pp. 7). Further level of granularity will require more elicitation, conflict resolution and categorisation, perhaps at programme / subject discipline or module levels to determine specific requirement for ML sessions. This is beyond the scope of the review of this thesis but may be a consideration for further studies. It is anticipated this will not only generate awareness for ML and MDTs but help reveal how achieving ML objectives in teaching sessions may also contribute to the achievement of strategic objectives.

7.7. Limitations of the modelling process

One of the main limitations of requirement analysis process and modelling in general is the tendency for the end products and specifications to become too abstract or too complicated (or both), to be understood. For example, a document containing the model images in Figures 7.5 and 7.6 (the system-as-is and the system-to-be), along with a brief explanation, was emailed to the stakeholder participants in the review of this thesis for comments. The intention of emailing only the system-as-is and system-to-be images was to simplify the consultation process. It was also considered opinions on these two will be more useful for the review of this thesis.

There were only four responses to the request and all four suggest the models may be too complicated. The following comments are representative of some of the responses received:

> *"At certain level of complexity, there is a danger of diagrams clouding rather than elucidating meaning … especially if there is no mechanism to work separately at different levels of granularity, and if not all the diagramming tools are actually deployed."*

> *"If people are not diagram-literate then perhaps diagrams, complex ones, could be disempowering, giving the impression that an expert has taken over."*

These views also support findings in literature which suggests requirement analysis and modelling techniques may add complexity and lack of clarity in system analysis, making them unusable by anyone but experts in RE or Software Engineering (Ullah & Lai, 2011).

Efforts have been made to limit the amount of complexity involved and to select a methodology offering relatively simpler notations framework considered more readily recognisable. However, the fact remains the symbols and notations may only be recognisable by "experts" or by providing extensive explanations, and this may render the models unusable, as was suggested by one respondent. It was also impossible to provide the level of granularity that may be necessary for usability given time constraints. Applying the models in a generic sense without making significant modifications – perhaps because the actors, roles, positions etc., specified are unsuitable – may also render the models unusable.

Three respondents agree the model in Figure 7.5 especially seem an accurate representation of the state of ML. Two suggested the models could act as a way of "*starting a discussion going and generating further initial interest*", which one add will only occur "*if accompanied by explanations – perhaps in a paper, presentation or workshop*". It is unclear if the respondents would have made different comments had they been supplied with all the models or perhaps the content of this chapter to provide contexts for the two models.

Therefore, another limitation is the very brief consultation / validation process. Once requirement specifications have been established and all the models have been designed to the lowest level of granularity, a narrative may be created around the result and a period of consultation initiated with stakeholders to evaluate the results. Berenbach et al (2009) suggest scheduling several QAWs and brainstorming sessions with each group of stakeholder in an extended consultation period as necessary. The process should be aimed at identifying / correcting errors and establishing acceptance.

7.8. 'Mobility in learning': Strategies for normalisation

In this chapter, the Tropos methodology for AOSE in conjunction with RE goal modelling techniques, was employed to produce a series of illustrative models for ML ecosystem environment from elicited requirements supplied by stakeholders in HEI, strategic policy documents and quality dimensions. In summary, some of the models are as follows:

1. ***Figures 7.2 & 7.3:*** *Structure-in-5 organisational model showing functions within HEI, actors (units), agents (sub-units), hard and soft goals, tasks and resources.*
2. ***Figure 7.5:*** *System-as-is goal model for ML showing relationship between softgoals, along with system "helps" and "hurts" and associations with quality dimensions.*
3. ***Figure 7.6:*** *System-as-is goal model showing relationship between goals in terms of contributions (satisfactions and denials), reflected using AND, OR, ++, +, -- and – operators (Kolp et al, 2003).*
4. ***Figure 7.7:*** *Actor diagram for Learning and Teaching Execution (LT&E) – the operative core, showing dependencies as depender → dependum → dependee; as well as positions, roles, resources, hardgoals and softgoals within the system.*
5. ***Figure 7.8:*** *Means-ends decomposition of Learning and Teaching Execution (LT&E) – the operative core, from the perspective of the Academic / Learning Instructor / Tutor, showing a means-ends analysis for the goal "Flexible options for a more distributed, mobile & time-conscious market" – G150.*

The listed models represents four of the five stages of the Tropos methodology: early requirements, late requirements, architectural and detail designs. To complete the modelling process, decomposition / means-ends models need to be derived for other goals within each realm of operation in the organisation (see Figure 7.2). It is proposed in this thesis such an environment is necessary for ML and successfully integration of MDT in learning and teaching in a sustainable manner.

One thing that may be clear from these models is they are based on the hypothesis that ML and any effort to integrate MDT into teaching and learning must be aligned with the strategic policies of a learning establishment. This is not only because achieving ML goals contribute positively to achieving the institution's strategic goals, but also because not achieving the goals may result in not achieving institutional goals. In that sense, ML and the integration of MDT into teaching and learning must be seen as an integral part of an institution's core operational strategies from day to day, fostering an institution-wide MDT-friendly environment.

For example, the system-as-is model in Figure 7.5 may have demonstrated that when '*robust & innovative technological infrastructure & network platforms*' are not deployed, it is unlikely goals such as '*provision of flexible options for a more distributed, mobile & time-conscious market*' can be achieved. Equally, when '*learning spaces are not customisable*', 'digital mobile learning spaces' will likely be restricted and limiting. Teaching and learning opportunities will of necessity be limited to classroom / timetabled meetings. Therefore, achieving learning that is 'innovative, transformational, engaging, authentic and measurable' may be difficult or impossible; not to talk of achieving overarching goals such as 'high HEI reputation and status', 'high level student admissions' or 'high level staff and student loyalty' etc.

In spite of the criticism levied against the modelling process, outlined in the previous section, it has been accepted they could provide useful ways of exploring a system. Therefore, one of the main objectives of this chapter is to provide a visual representation of the system-as-is and system-to-be models, and also to illustrate the likely placement of MDT and ML in achieving the strategic goals of an institution. In the absence of concrete ways to evaluate ML and evidence benefits to learning, it is assumed a 'visual' link with institutional goals may provide a way forward, or at the very least, start a discussion going as have been suggested by respondents consulted on the system-as-is and system-to-be models.
The other objective is to present the findings of the review of this thesis from a

different perspective for ML and the integration of MDT in learning and teaching. To achieve that purpose, categories used in ML evaluation criteria and indicators (Table 2.6) first proposed in Section 2.3.5 and derived from the ELI (e-learning indicators) by Fetaji & Fetaji (2009, pp. 4-5) have been mapped to elicited findings. These in turn have been linked to some strategic objectives relevant to the domain and quality dimensions for HE to create a conceptual system-to-be. It is anticipated, again at the very least, this may highlight some of the important and relevant points made by the participants to the review of this study and provide a way to evaluate the process.

Some evidence of the necessity for change may have become apparent in previous chapters and especially given the empirical evidences presented in Chapter 6 and again more graphically in this chapter. As an academic respondent to the review of this thesis stated:

> *"We don't want to be crowding hundreds of students into lecture theatres just to listen to some sage learning. Sometimes, it is important, but it shouldn't be the norm and it's not … well, I don't know how to put it … For some, it might be. For some students, it may be exactly what they want. But for the majority in terms of an enhanced, rich, enjoyable, engaging experience; it's not something you want to be doing as the norm anymore."*

The academic added:

> *"In the current sort of shift going on in HE, the increased amount it's costing and things like that, we need to be exploring different ways that the learning is engaging, you know and enjoyable, and exciting and challenging of course because it is higher education after all."*

The implication in this statement to which five other participants agree, including three at governance level in HEI, is there is a cost attached to learning provision that is lacking in innovation and steeped in "*traditional learning paradigm*". As a member of the governing body of a UK HEI puts it.

> *"If I could go back to teaching, I wouldn't be able to ignore the technologies because I'll feel so detached from the students in the classroom. I'll have no*

idea what's going on in their heads … what they are thinking, if they are engaging. I think their thinking process will be different from mine which is a product of the traditional learning paradigm …"

So, there is an additional complication in the perception that, of necessity, today's learners need to think differently; acquire, handle, process and interpret / make meaning of knowledge and the events around them differently. These issues will be explored further in the next chapter where some of the findings of the review of this thesis will again be presented from a different viewpoint.

Chapter 8

Everyone is following, everyone is liking … but no one is understanding.

~ Will.i.am on BBC Click programme, aired 6 July 2014

By seeking and blundering we learn.

~ Johann von Goethe

Achieving mobility in learning: Conclusions and recommendations

8.1. Discussions and implications

The review of this thesis have highlighted factors and concerns in the perspectives and opinions of several stakeholders in education and in HE for ML system and the integration of MDTs in learning and teaching. Many of the discourses have confirmed the fundamental hypothesis on which the review was founded: that while there may be ready availability of MDTs and while many students may be using them informally to support and enhance their learning, more needs to be done by HEI stakeholders: governance, practitioners and students to advance the agenda forward for ML, such as normalising the structural use of MDTs and fostering an MDT-friendly environment.

It may be fair to say there is still a question about MDT's placement in education even among stakeholder participants. Some feel its integration is inevitable while others suggest there are some issues yet to be resolved before integration can occur. The VC of a London University explained:

> *"Going through university is about so much more than the content of the individual modules. It is about learning how to be a citizen, meeting other students from other contexts and all of the things you talk about in terms of social interactions and not just about digesting information."*

There may be agreement on this. What is not clear are the route(s) to achieving these aims. However, this research has shown in Chapter 7 using a series of modelling techniques, it may be in the best interest of HEIs if they prioritised achievement of ML and integration of MDT goals alongside other strategic objectives and quality dimensions. The models in fact revealed achievement of strategic goals may not be satisfied fully unless ML and integration of MDT goals are satisfied and vice versa.

Considering the issue, an academic suggested the question we should be asking may be: "How can we help learners to understand that these instances of social interaction have got learning potential in terms understanding the world better, finding their way in the world better … but also, contributing to formal learning outcomes better?" In this chapter, some suggestions and recommendations are proposed, including how MDT may provide answers, at least in part. Also in this chapter, discourses presented previously will be summarised, while highlighting noteworthy phenomena of interest, suggesting areas requiring further research and suggesting some recommendations for the future ML implementations and practices in UK HEIs as well as similar learning establishments.

8.2. The research study

In Chapters 2, 6 and 7 and Section 8.4.1, answers to the following sub-questions, summarised and consolidated from those guiding and underpinning the review of this thesis as outlined in Section 3.2.1) were presented. The findings and specific areas corresponding to these answers, and to the aims and objectives summarised in Section 1.1 of the review of this thesis, are discussed in more details in the next section.

1. ***To what extent has HEIs' adoption and integration approaches as well as the promotion of ML contributed to the progression in learning and teaching, and educational transformation?***

2. ***What are the evidences supporting the effectiveness of HEIs' integration approach and in the promotion of mobile learning?***

3. ***If mobile learning as a theoretical practice and learning type is not to be consigned into obscurity, how can we encourage a merging of theoretical and practice-based understanding of the concept that informs future undertakings?***

4. ***What is the nature of the evolution relationship between education and mobile device technologies in a learning process?***

These questions were aimed at providing a framework within the study to answer the main research question:

To what extent and in what ways has ML using MDTs been integrated in learning and teaching in higher education since its conception?

A mixture of methods and analysis approach was employed, involving quantitative methods such as survey and questionnaires as well as qualitative methods such as interviews, focus groups in a longitudinal study over the span of one academic year and shadow observations. The data was collected over a period of approximately four years in a progressive study (see Table 3.1). Due to the constantly shifting parameters of the review, primarily caused by rapid changes in technology as well as access to relevant participants, the research design and methodology underwent several changes.

For example, case study research was planned among students on similar course programmes in two of UK's universities in the last two years. However, access was withdrawn to the cohort in one of the universities unexpectedly. The case study was subsequently replaced by longitudinal studies: focus groups among pre-service tutor students and surveys among "freshers", newly enrolled on course programmes in a UK university. Planned observational visits of pre-service tutors on placement was also impossible as a result of the inability to obtain Disclosure and Barring Service (DBS) – a merging of Criminal Records Bureau (CRB) and Independent Safeguarding Authority (ISA) – which is a requirement for going into Schools, in the time span available.

While originally unplanned, these changes may have provided a richer context from which in-depth understanding can be gained about the domain as relevant to the research questions, allowing for potential differentiations among the student groups in terms of subject matter, educational level and age / gender comparisons. It was also possible to explore practices among two groups of educators: academics in HE as well as students who are pre-service tutors studying in HE for a teaching career in Secondary schools.

The relatively short "burst" element characterising data collection phases also made it possible to accommodate changes in technological advances and address these issues in subsequent studies as they occur. This resulted in an array of data on perceptions gathered through different approaches within the domain. As discussed in Chapter 3, a mixture of approaches have been found to help overcome drawbacks inherent in using one specific approach.

8.3. Contributions to knowledge

Arguably, and as a participant to the review of this study suggested, "*there's* *been no alternative*" for the way we "*do learning*" for millennia. In contrast and in the last decade alone, MDT development has progressed at an astronomical speed, its use becoming normalised in the society and among students and other stakeholders in education. The review of this study show students, academic tutors, learning support and governance as well as other stakeholders with vested interest in education will increasingly see the gap widen between what's done in learning and teaching and that which occurs in societal constructs unless something changes.

As a functioning microcosm within the society, education should reflect the society's properties and characteristics. The findings of this research study shows it does not, at least in relation to ML and the integration of MDT in learning; Figure 1.1 locating ML and BYOD strategies in the trough of disillusionment in a TEL hype cycle (Walker & Voce, 2014). The review of this thesis has contributed a way forward by suggesting some measures that may be useful, leading to several important contributions, achieving the aims and objectives outlined in Chapter 1, and answering the research questions outlined previously.

In Chapter 2, a systematic review analysis of existing literature examines previous approaches to the examination of MDT adoption and integrations and the practice of ML and in Chapters 5 and 6, findings from secondary and primary sources were presented suggesting factors relating to the adoption, integration and sustenance of MDTs in learning processes and its impact on the transformation of instructional designs and educational processes. In the field of Computing, the research study contributed through the application of abstract modelling techniques of RE and AOSE disciplines. Also significant is the elicitation processes conducted among a variety of stakeholders in education. These approaches have the potential to forge a new path for ML in future.

Also significantly, the studies led to specifications of goals and requirements for ML and for the adoption, integration and sustenance of MDTs in learning processes. They also led to the identification of a set of attributes hurting or helping ML systems. The results were useful in deriving 'system-as-is' models in Chapter 7. 'System-to-be' models were also developed in Chapter 7 to illustrate how elicited goals may be aligned with institutional policies and strategies.

In addition , a key contribution of the review of this thesis include the revelation of the extent to which there may be a mis-match between what student want and what's actually provided. For example, there is an assumption which may not be totally unfounded that students prefer face-to-face learning and to sit "*in a classroom and listen to a teacher*". Academics confirmed students have complained in the past when they fail to get that experience. However, participants in the review of this thesis also suggest HEI stakeholders seem to go out of their way to reinforce that expectation. One academic commented: "*I think in their first year, it's our responsibility and we've got an opportunity to disenfranchise them from that, get them to think differently. But we don't, we plunk them in classrooms and we re-enforce that expectation.*"

While students may feel they need face-to-face learning, it is unlikely they'll think differently unless a much better option is offered. In that respect therefore, this review may have contributed by proposing that a discussion is necessary, which may include a "what if" scenario along this particular track. This suggestion may lead to an equally significant contribution which concerns how the strategic goals for an institution may be aligned with what it does in practice. There are evidences in literature suggesting one of the greatest barriers for moving the agenda forward for ML is difficulties evidencing benefits. The review of this thesis has provided a way of doing that, by revealing how an institution's strategic goals are being hampered or prevented from being achieved by strategies that does not prioritise integration of MDT and advancement of ML as part of its overall product / service provision.

The working definition derived for ML in the review of this thesis which is based on current practices and findings from literature and from the review process may form the basis for the next contribution. ML is defined in this review as:

> *"A form of learning in mobile and ubiquitous contexts and spaces, which benefits from educational affordances present in the MDTs involved when underpinned by sound pedagogical principles and resulting in the achievement*

of the learning objectives set."

As mentioned earlier in this thesis, the emphasis here is not exactly that of establishing yet another definition for ML but to highlight essential ingredients considered necessary as differentiators of an ML process from other learning types. Also, the definition suggest sound pedagogical principles alone may be inadequate in achieving desired outcome for learning. An academic offer this definition / description for pedagogy: "*Pedagogy is an intention, a design. It is also what you do when you are attracting some people, it is a performance as well.*" The key phrase in this quotation is of course "*attracting some people*". Many would agree HEI is in the business of "attracting" students. The academic continues:

> *"You can have good intentions and mess up the performance. You can have misguided intentions and the performance go fine. So there is a sort of lose link between them. And you as a teacher is not the only one controlling that. The learner obviously have a huge role to play: How do they react to your performance? How they give you feedback and choose to adapt it; it's an evolving process ... I think we should worry about pedagogy but I don't think we should pretend we have an answer. I think there are things [we] can worry about more such as thinking a bit more outside the box about teaching and learning in general."*

Other academics also suggested thinking "outside the box" may be long overdue, but many also feel there are several barriers in the way still. They acknowledge a definite start has been made, concerning making the infrastructure robust, provision of BYOD support and other similar schemes for example but much more is needed if we are to start thinking, in the words of a member of the governing board of a UK university, of getting "*out of a bad place to a better place*"; and once in a better place, "*striving to get to a great place*".

The review of this thesis also reveal limitation of some of the previous approaches in the domain which may be as a result of isolating the problems from organisational policies as is often common, and the failure to propose sustainable solutions for issues identified. The phenomenon has led to the frenetic search, certainly in the past, for evidence of benefits to learning. The review of this thesis has found that in fact, a rationale can be found in the damage done to strategic policies when ML and MDT integration goals are not achieved.

Last but not the least, apart from attempts to evidence benefits, creation of framework and guideline models are other measures suggested in the last decade for moving the agenda forward. While not suggesting there is validity to this premise, this review has contributed a set of indicators derived from e-learning benchmark methodology of ELI (Fetaji & Fetaji, 2009) to evaluate framework models as well as ML practices.

The indicators and the result of the evaluation of some of the existing framework models are important contributions to knowledge, not only suggesting evaluation strategies, but also revealing advantages and the disadvantages of using the framework models. Another key contribution is the linking of the indicators with goals and requirements modelled in Chapter 7, providing another way to evaluate goal achievements.

8.4. Implications for the future of ML

ML ecosystem models presented in Chapter 7 revealed among other things, the importance of adopting an organisational approach to the issues plaguing ML, effectively viewing its goals as subsets of the overarching goals of the organisation. For example, a case in point may be some of the frameworks evaluated in Section 2.3.5. Evaluation would imply that while the models may resolve some issues, they are unable to resolve others, relating to integration and sustenance in education.

A second consideration concerns one of the proposals of the review of this thesis for overcoming a barrier for integration relating to rapid innovations in technology. It is often the case that while education may have appropriated some technologies successfully, there is an impression in other areas it is playing catch-up and sometimes, functioning on infrastructures that are dated or worse, obsolete. Lacking infrastructure provision and network platforms is one of the obstacles suggested by academic participants preventing technology use in learning. Not only that, many academic admitted they feel overwhelmed by the number of available options.

The question is therefore asked if a co-evolution relationship can offer a way forward for the future of ML. Should educational strategies and instructional designs evolve at the same rate as MDTs for instance, to take full advantage of innovations in development? If they were to evolve at the same rate such that they have a mutually beneficial relationship where advances in one drives the other, would that help achieve greater integration in learning processes for MDT and an advancing of the agenda for ML?

8.4.1. The co-evolutionary concept

Co-evolution is an abstract concept describing how evolution in one entity may drive evolution in another and vice versa. The concept is studied in Science disciplines, specifically biology, to explore the behaviour of ecological organisms and the relationships between plants as well as plants and animals, typical in classic survival mode. Development in a particular species of plant could benefit another species and adaptation or counter-adaptation in the latter species may affect the first (UCL, n.d.). Reciprocal relationships between co-evolving entities are not always positive; often fitting "survival of the fittest" patterns.

Co-evolution could be *parasitic*, *commesalistic* or *mutualistic*. When *parasitic*, one benefits and the other is at a disadvantage. In a *commensalistic* relationship, one benefits the other is unaffected. A *mutualistic* co-evolution provides that both entities benefits from each other in a mutually beneficial relationship (University of Texas n.d.; Hogan, 2012). For example, in plant systems, Angraecoid orchids and African moths are said to be in a mutually beneficial co-evolutional relationship because neither can survive without the other. The moths depend on the orchids for nectar while the flowers in turn depend on the moths to spread pollen so they can reproduce[7].

Co-evolution concepts have been applied to explore technological relationships

[7] New world encyclopaedia (2007): http://www.newworldencyclopedia.org/entry/Co-evolution

with several other entities in recent times including organisations, the environment, the marketplace and even learning formats. An example is a study into the co-evolution of technological innovation system (TIS), markets and institutions by Nygaard (2008). The review of this thesis explored stages in co-evolution with the aim of specifying stabilisation mechanism for such a relationship. The implication is when a mutually stable co-evolutional relationship occurs between two entities, the chances of both surviving and thriving is much greater.

Similar notions have also been explored between technology and learning formats, inspiring the notion such a relationship between MDTs and educational processes may be a way forward for ML. Thus, one of the consideration for the review of this thesis is to gain an understanding based on perceptions and opinions of various stakeholders in educational community.

Interviewed participants who are academics and other stakeholders, including those in learning support and governance, educational theorists and ML proponents from various universities in the UK were asked about the concept of co-evolution as an option for a mutually beneficial relationship between education and MDT and about the parameters of operation within such an environment. To gain further understanding on this issue the following are the guiding hypotheses explored.

- A *mutually beneficial* co-evolving relationship between MDTs and educational processes could be an essential part of the strategies for learning transformation.
- An effective *mutually beneficial* co-evolving relationship between MDTs and education will promote flexibility and mobility in learning, enhancing learning experience and resulting in greater achievement and retention.
- Higher educational institutions require guidance and sharing of exemplar good practice to promote a *mutually beneficial* co-evolving relationship between MDTs and education.

Two of the participants, both members of the governing board of their respective institutions were unable to see the point of a mutually beneficial co-evolutionary relationship, the latter supporting the idea that co-evolution already exist between MDT and education:

> *"Having education drive the agenda, what would that say? Whatever education need that isn't provided already, they can always appropriate something and build on that. And as part of the society, they feed into the design and innovations and marketing data that device manufacturers use to improve devices."*

> *"You only have to look at the evolution of these devices. They will only evolve in a way that aids the user … And I believe it is a 2-way street – these devices change slightly in line with the way we behave. But at the end of the day, it is a form of technological determinism to just say that HEI is going to evolve or should evolve because of the direction of technology … or that educational process should be driven by evolution in technology."*

Those believing co-evolution already exist account for 19% of all interviewed. These comments may sum up the sentiments expressed:

> *"It's sometimes the case that technology can lead to a step back in teaching. Interactive smart boards in schools and colleges are examples of that. So you know there's a massive investment made by budget holders with little consultation about the investment in this 'great new tool' which then appears in schools and colleges seemingly overnight and then little effective training in their use. So what they become is vehicle through which lecturing takes place and in some cases some good learning and teaching gets missed and some bad learning and teaching happens as a consequence. So I think there's a … I wouldn't say co-dependent … say semi-biotic relationship between positives and negatives."*

> *"I think that's happened. I mean, students bring their devices into lectures to record stuff. I think society as a whole is driving innovations in devices and I think education is part of that society. So I think there is some influence from education back into these innovations. You are probably right that it is not very direct but we do have people developing educational apps. But I think ultimately, education is probably good at improvising with whatever they get."*

Others (52%) believe there is no co-evolution, nor could there ever be:

> *"It is a good and noble idea but probable … No. I don't think education system is a significant enough industry to influence manufacture of mobile device technologies. If you look at what educational technology there is, there's very little of it. We use or appropriate business technologies … word processors / spreadsheet applications etc. … which are essentially dedicated business applications. None of them were developed for education, they were appropriated."*

> *"Yes, we do seem to be chasing gadgets; shining new things; Apple and whatever it is … I think it's because in the heads of the companies, users are users. They create the material, market it, and we've all just got to use them. So I don't think they are good at responding ... We don't have the clout to change things ... They just say this is the next big thing and we fall in line … I think they are very bad at taking response from their users. Even when they do, they tend to say this is the way we are going to do it. We say we'd like a USB port in iPad / iPhone please and we'd like flash on iOS … So, they are dictatorial in that way."*

A member of an HEI governing board admit we are playing catch-up but suggest this may not be a problem:

> *"I guess in many ways it's mostly consumer-driven, isn't it? It's about what will sell or doesn't sell. But I think that's ok, actually. I think we should always be slightly behind it [advances in technology] because then it'll be tried and tested by the time we get our hands on it. If we're in from the ground up and spend millions of pounds on getting it to work I don't think that'll be good use of the funding we get. So by the time we get it, we know they work and we know what we can or cannot expect from it. So I think we should always be slightly behind it for that reason."*

This comment highlighted a problem illustrated in the hype cycle of technology, suggesting it could be very expensive to be early adopters of technology or aim to be at the fore-front of innovation (see Figure 1.1 and 1.2). The rest of those interviewed on the subject were either unsure or they fail to provide an answer one way or the other.

Those agreeing a mutually beneficial co-evolution relationship could be useful were asked to suggest parameters on which such a relationship may operate. Their responses have been categorised in Table 8.1. Perhaps not surprisingly, one of the most popular desirables concerns is the rapid advance of technology. Some of the comments include:

> *"If you could stop time ... to get to grip with everything ... I think once you get on this never ending wheel, you find you are constantly trying to catch up and have to keep going with what's there. You are never able to get to grip with one before another comes along."*

> *"The problem is we are not slightly behind, we are a long way behind and by the time we catch up, they've moved on to other things. So I think what we need to do is close the gap so we are just behind and that will be good. I think if we think about it as just a device then it'll be a problem, but if we look at what it enables: access and connectivity everywhere, then it probably doesn't matter as long as we are not so far behind it becomes obsolete before we catch-up."*

Table 8.1: Parameters for co-evolution between MDT and education

Categories	Parameters of operation
Standardised platform and interoperability for integration / appropriation	Stable platform in the way they are designed in the same way as we have with the PC; integration or appropriation into learning systems (e.g. VLE)
Education / educated in control	Body of people involved in this get bigger and bigger
	Make education much more accessible to many more people
	Influence the development of the newest thing
	Education control what it does / how it works
Controlled pace of advancement to suit education	Technology is not moving so fast we can't keep up
	When new versions come out, we get advance notification and we are given time to test them on our systems
	Need time to get to grip with new technology and not constantly trying to catch up
Space for brainstorming / incubator thinking	Safe space to begin to explore ideas and prompt students to acquire critical thinking skills
	Educators sitting down in "thinking environments": (we are not giving them time to do so). We need educators to start thinking in inventive mode
Seamless learning	Facebook[-like environment]: a friendly 24/7 seamless learning access environment
Curriculum development	Curriculums is not built around a new technology
	Curriculum reflect changes in technology

This implies attempting to catch up or stay just behind may be an acceptable position to be. Some went a step further, advocating we should be ahead of the movement:

> *"We need to find a way to be able to grapple with these changes and get ahead of it if possible, even initiate some of these changes; become change agents … The technology's got to exist and keep innovating, but we've also got to produce people that buck the change, push boundaries, become the next change agents."*

However, some feel playing catch-up may be all education can do:

> *"I think we'll always be playing catch-up to technology. It will always be the case where you are responding to the newest thing. Maybe a few university may influence the development of the newest thing, but I think we just have to accept that for most of us, we will always be playing catch-up."*

The participant went on to suggest how we might cope with the problem:

> *"I just thought maybe what we need to think about in terms of the curriculum, maybe part of our job is helping students to understand how technology can or is part of their lives … how it enhances, not just their education, but their life generally and how they can best use it to do that … responsibly, so that it doesn't have to dominate their life. Use it responsibly, beneficial, enhancing … maybe that's where we need to spend time with students."*

This comment suggests there is an impact on private lives, an intrusion perhaps that has only been peripherally explored in the review of this thesis. While recouping "dead time" or supporting students to study in their spare time may be desirable, it is also the case, as found in literature that information overload and unwanted intrusion may result. A participant described the problem:

> *"The fact that connectivity is always where you are, intruding on your holidays and your 'me' time. That is why this is irritating to me. I don't really mind having to check my emails late at night or early the next morning too much because if I've got meetings all day and I've got 100 emails, I need time to catch up otherwise it'll just build up in the long run and I'll never get to some of them. It is the fact that everyone just think reaching me is open season regardless of where I may be or may want to do instead."*

Interestingly, in the comparison study undertaken by this study, academics, students and those in the role of learning support and governance were asked to rate the most serious barriers to MDT, "*Intrusion / disruption to personal time / space*" a metric. It was rated 18th and 17th respectively, by academics and students while those in the role of learning support and governance rated it 23rd among a list of 26 barriers (see Part C, Q6, Appendix 19). This may suggest the intrusion may not be as keenly felt by MDT users as have been suggested in literature (e.g. Shih, 2005; Stewart, 2013; Nerantzi et al, 2014).

If a mutually beneficial co-evolution relationship between education and MDT (or other forms of technology in general) is an unachievable goal, over half of the interview participants for the review of this thesis (52%) would suggest learning establishments ensure they "*are not so far behind it becomes obsolete before we catch-up*". Another aspect that did not go unnoticed is the consumer-driven aspect. Just over 20% suggested members of the educational community as a consumers of technology do influence technological development to some extent.

Therefore, education may be unable to take complete control, working "*from a participatory position*" and controlling, but perhaps members of the community, such as the stakeholders interviewed: academics, students and those in the role of learning support and governance may become change agents as was recommended by a participant, and influence technological directions for the better. It is believed that as the body of knowledge increases, influence realms will also widen.

8.4.2. Implications for policy and strategic goals

Table 1 of Appendix 4 shows the likely goals of an institution. This has been modelled in Figure 7.6 in a system-to-be model. The goals show *increasing student admissions* at the top with *increase HEI's reputation & status*, *increase student satisfaction & engagement* and *increase staff & student loyalty* following. These are undoubtedly likely to be the overriding desires of any self-respecting institution.

Achieving these however require that the contributory functions and goals are achieved. Some of these have been listed in Table 1 of Appendix 4, ranging from improving quality of teaching & learning, increasing student success and increasing transformational opportunities to removing barriers to progression and increasing employability & career prospects. The models depicted in Chapter 7 show how these can lead to the achievement of overarching goals.

8.4.3. Implications for teaching and learning

Teaching and learning execution as part of the operational core have been modelled conceptually in Figure 7.7, showing how, not only the *instructional design* as well as the *teaching and learning delivery* will be affected in an ML environment, but even *curriculum / course / programme specification* and *timetabling design* must be structured in such a way to provide flexible learning options in digitally enabled spaces within an ML environment. Learning systems, assessment, documentations or course resources etc., must also be considered from this view point.

It may sound daunting, but the review of this thesis suggest an overhauling of traditional system may be necessary and peripheral fixes inadequate. As one academics said, this can only result in placing "*a square peg in a round hole*" and our progress until now suggest there are issues to resolve still. A participant suggested some academics encourage their students to use social networking sites like Facebook as part of their instructional deliveries because it (a) is easy for them to use (b) available 24/7, (c) in a trusted and robust environment (d) offer a friendly social platform for learning.

The same participant derided the state of most Managed Learning Environments (MLEs) or Virtual Learning Environments (VLEs) or Learning Management Systems (LMSs) etc., owned by some institutions. More than one participant agreed; criticisms including restricting, less than robust, limiting, less than intuitive features, not user-friendly, performing too many roles and none of them very well etc. The suggestion is students are unlikely to engage with such systems and platforms if they are not seamless and usable, as they may be used to elsewhere. It is also believed high quality teaching and learning depend on how seamless, usable and robust these systems are.

ML in a blended environment is another popular suggestion for MDT integration in teaching and learning. While the idea inherent in the suggestion seem desirable, one of the problems as expressed by one participant is that it is often used as a "catch-all" term for all forms of technological integration, resulting in an acceptance of the bare minimum of integration that does not exactly transform the process in any way. It suggests an impression still of ML from the technology's point of view. Traxler (n.d.) would suggest looking at the issue, not as the "*mobile bit of learning but the learning bit of mobile*".

8.5. Recommendations

The recommendations from the review of this thesis is rooted in viewing and seeing the goals for ML and integration of MDT as an integral part of achieving the strategic goals of the learning establishment. For example, if digital ML spaces (customisable & scalable), robust & innovative technological infrastructure & network platforms, seamless access to learning platforms across devices and networks, learning / content for variety of platform are all provided; along with making an effort to increase staff & students' expertise / competencies on effective use of innovative technology, goals for ML and MDT integration are likely to be achieved and sustained in such environments and so on – all part of the strategic goals of an HEI.

Recommendations relating to key institutional goals, quality metrics and other realms of operations are outlined in the following sections. Some have been expressed in models presented in Chapter 7 and in Table 1 of Appendix 4. They are expanded here as pertaining to specific operational areas.

Strategic policies, governance and planning

It is recommended that strategic policies of the learning establishment are seen in the light of enhancing ML and MDT integrations in learning and the latter is not seen as an isolated strategy to be achieved. MDT-friendly environment should be encouraged and promoted across the institutions. Goals for ML should be aligned with the operational goals of the organisation as a whole and a collaborative effort among all stakeholders must be encouraged through each of the organisation's activities. Strong IT service / support leadership is recommended, along with an institutionally driven ML vision and planning, which takes the needs and day-to-day practices of staff and students into consideration. These measures will engage both staff and students and promote a blissful satisfying environment in which both can thrive and succeed.

Robust technological infrastructure and support

It is recommended that organisations or learning establishments provide a robust and considered technological platforms and infrastructures including ML learning content and applications, and robust IT service leadership / support. All support schemes, such as BYOD and tablet issues to students should be seen from the point of view of learning enhancement in the first instance, and treated as such in terms of strategies, estimation of requirements, guiding strategic policies and execution. Therefore, considerations for their provision should include robust supporting structures and adequate (and regular) consultations with staff and students before, during and after implementation.

The following recommendations suggested by Dahlstrom & diFilipo (2013) for BYOD scheme implementations are also considered crucial for ML systems implementation:

- Maintaining a balance between rigorous security standards (managed risks) with user (in)convenience.
- Accepting proliferation of user-provisioned technologies does little to change the basic best practice around security. A solid security presence and plan should adjust to most BYOD challenges.
- Managing risks through securing data (access) rather than devices (assets).
- Collaborating with other units such as human resources / staff development departments to establish user-awareness training and staff development programmes that focus on the understanding of risks of data exposure, how users can avoid security breaches, and how users can separate work and personal usage.
- Avoid implementations that prioritises cost savings above investment in infrastructure.
- Reconsider reimbursement plans for BYOD and retain these services only if there is the right combination of political and financial investment for the institution.

- Invest in IT infrastructure “middleware” that is invisible, frictionless and robust yet nimble in order to bridge the connection of users / devices and systems / services / data.
- Have clear and accessible support service-level options.

Dahlstrom & diFilipo, 2013, pp. 37-38

Customisable, scalable and digitally enhanced learning spaces

It is recommended that the organisation or learning establishment provides learning spaces that are customisable and scalable; capable of supporting and encouraging learning sessions that are:

- engaging i.e. allowing room for collaboration; knowledge construction; learning immersion, reflection, interpretation, analysis, application etc.
- authentic i.e. providing ample opportunities for application of new knowledge to real world solutions, integration of problem-based and knowledge-based instructions.
- measurable i.e. teamed with continuous reflective evaluation of instructional design and delivery.

Such spaces should be capable of supporting flexible options, and seamless formal and social learning sessions.

Satisfying staff and students needs

It is recommended that staff and students’ needs are established in terms of technological competencies and once established, innovative competency training should be provided and made accessible in a variety of ways and formats to both staff and students allowing a range of options that encourages both staff and students to allocate time to increase their expertise / competencies on effective use of innovative technology.

Training options should be offered in a flexible manner to encourage participation e.g. online options, push notifications and content to mobile devices, publications as well as face to face options for those preferring this mode of learning. Rapid changes in technology should also be taken into consideration and anticipated. This should be reflected in staff development and support to prevent staff and students from feeling overwhelmed by the number of options available.

Opportunities for ideas incubator / brainstorming and innovations

It is recommended space and time be allocated to both staff and students to develop ideas and "out of the box" thinking, offering reward accordingly for outstanding efforts to encourage ongoing participation and quality input. This should include encouraging time for pilot testing of ideas and allowing time for implementation and review before new ideas are considered and implemented. Maintaining an increase in innovation and commitment to excellence activities should be prioritised and encouraged as well as increased regular review and evaluation of practices to ensure continuous innovation.

Curriculum / course programme development

It is recommended that programmes are designed and developed in an innovative manner with flexible options suitable for a more distributed, time-conscious market. Programmes should be designed to suit the learners and provide ample transformational opportunities for the learner not because they are sellable or attract many students. Opportunities for ML and MDT integration should be incorporated into all curriculum / course programme implementations.

Curriculum / course programme time-tabling

It is recommended that course programmes are time-tabled in such a way that it is not restricting and limiting. Contact time with academic staff should managed in a way that encourages flexible solutions and options supported by MDT-enabled synchronous / asynchronous interactions in / out of scheduled sessions. If students are supported to appreciate the benefit inherent in unrestricted access to learning and learning spaces, it is anticipated that they will be more appreciative of the flexibility in the offerings.

Teaching and learning

It is recommended that an ML culture is encouraged among staff and students with robust support structures for MDT-accessible learning / content provision. Academic staff should be encouraged to propagate an MDT-friendly environment driven from the top in all sessions, championing a paradigm shift that supports students in their first year to adopt a DYI (Do-it-yourself) learning practice. This will disenfranchise students from traditional expectations held when they come to the university by the time they are in their second year and reduce the general belief face-to-face sessions are best, without due considerations for other options.

8.6. Study limitations and validity of data

The comparison survey among academics, those in the role of learning support and governance, as well as students may be one source of inaccuracy because the choice of which survey to complete was left to the respondents in the online system which was not set up to collect personal data. It was impossible to tell if those completing are really who they say they are. It was also impossible to tell how many of those completing the survey for "those in the role of learning support and governance" are in learning support and how many are in governance positions. This distinction was one of the sections left out of the survey to reduce the time duration for completion. It was decided this distinction may be less important than others.

A note-worthy comment by one of the learning support and governance respondents to the online surveys seem to indicate there is a bias or skewness perceived in the way the questions have been asked. The responded stated:

> *"My big concern is with whoever wrote this survey and their worldview of idle students wasting dead time and the agenda that underpins many of the questions and dimensions being used in this tool. The outcomes seem fixed and a really negative world view is inherently built in to many of the questions and scales."*

The criticisms levied against the research design was taken seriously but it seem unwarranted since there was no specific questions implying students are "*wasting dead time*". However, the comment was considered a useful point of view and a perception of the survey intentions that was explored during further analysis.

Another likely source of inaccuracy may concern the “freshers” study and the difficulties in getting continued participation from the first group of student recruits. Consequently, there was a disconnection from the first study conducted after they enrolled and subsequent studies at the end of the first and second semester which was conducted with a different group of students.

The final area of concern relate to the many changes during the review of this thesis ranging from those arising from technological advances to changes in the issues surrounding the domain. It is likely some of the findings presented in the appendix section may no longer be relevant by the time this thesis comes out in print.

8.7. Suggestions for further research

There are several lines of enquiry which will be of considerable benefit to the review of this thesis and to ML. The first concerns the narrowing of the research scope to HE in the first instance. Although there were some data available from other levels of the UK educational system, these are only complementary and may have no noticeable impact on the outcome of the review of this thesis. For example, many issues arose from the pre-service tutors’ study relating to the imposed ban on mobile devices in schools and the inequalities presented by infrastructure provisions. Consequently, a study relevant to these particular levels and other educational areas may be necessary to fully understand the domain of ML in these environments.

The second concerns the inability of the review of this thesis to present a case study testing some of the models presented in Chapter 7. Consequently, they can only be viewed from a conceptual basis and therefore unlikely to provide guaranteed results in other circumstances.

Thirdly, the changing parameters surrounding MDT restricted the longitudinal study to only one academic year. A study over a longer period, perhaps involving the same group of students over the course of their time in the university may provide much more reliable data, revealing other aspects this research may not be able to state an opinion on. Further studies into issues relating to subject discipline and the impact of that on ML and MDT integration may be useful. For example, there was a recognition that subjects such as Geography and Modern Languages may benefit from MDT use more than others.

There seem to be no remarkable difference between views and opinions in general among interview participants from post-1992 or pre-1992 universities. This may be because, although there were 6 institutions represented, majority (17) of the participants are from post-1992 universities. A study considering the effect of this phenomenon is beyond the scope of the review of this thesis. However, it may be interesting and useful to explore the phenomenon in more depth through further studies.

Finally, it may be necessary to explore the intrusive effect of MDT use among all stakeholders including staff and students more thoroughly. Although there were suggestions it could be a problem in literature (Shih, 2005; Stewart, 2013; Nerantzi et al, 2014), and at least two of those interviewed commented on their frustration with technological intrusion, the findings of the review of this thesis would seem to suggest otherwise (see Part C, Q6, Appendix 19; where it was ranked 17th by students, 18th by academics and 23rd by learning support / governance respondents).

This may indicate MDT users have developed coping strategies and are accepting of the intrusion; supporting the view frequent use could promote positivity and competence as suggested by other participants in the review of this thesis. Further in-depth study may provide more clarity.

8.8. Final comments

Some participants in the review of this thesis expressed some caution in the use of technology and some of these have been discussed in previous chapters. It may be useful to stress this researcher's fundamental believe that any integration of MDT in learning and teaching must be about enhancing and supporting learning and not the other way round. For instance, a participant made this comment to the researcher:

> *"It should be about how you engage the brain and sometimes, technology gets in the way of that."*

In such circumstances i.e. when technology is in the way, perhaps because it is a distraction or it has taken center stage in the learning process, it is defeating the objective and the goals outlined throughout this thesis are unlikely to be achieved. Therefore, ML must be seen from this perspective in the first instance.

It may also be useful if seen as part of the strategic ways an HEI may fulfil its promises to its students and perhaps achieve the overarching goals it may subscribe to, such as improving its rating and reputation, achieving staff / student satisfaction and loyalty, increasing student success, learner achievement and growth, numbers, employability and career prospects etc.

Achieving ML and MDT integration goals may not be the only way to achieve these goals but this thesis have shown that could play a part. In the words of an academic participant, it is time we stop "*'tinkering' with web 2.0 / 3.0 type technologies without really changing anything*" since "*the advent of VLE*" which seem to have stopped everything in its tracks.

There is also a feel that HEIs are failing students by not providing the right type of teaching and technological infrastructure they need to handle situations and events around them. An academic remarked: "*The speed at which you can do things has changed. With that of course is it generates so much volume of material.*" He added:

> *"Perhaps that's where students need a bit more help. And maybe it is about giving them a framework and teaching them what they need to think about and build their knowledge around, rather than just 'giving' them everything. Guide them through it a bit more and help them restrict their … no, not restrict their knowledge … but maybe restrict the volume they are exposed to and to be*

> *able to synthesise and select what they actually need from all they are exposed to."*

The academic added:

> *"There was something recently, I think perhaps in the paper, about how young people are kind of reckless with their personal information, compared to my generation. The concept now is that people who don't know them know a lot about them … and this is because they just recklessly put their personal information out there. Maybe that is where we can help students to understand … help them think 2 steps ahead; help them develop their thinking process …"*

Essentially, the general feeling is new skills are required for the technological age we live in which the students are not necessarily getting in their current learning structures: "*There is a need to ensure the curriculum is tailored to what's currently going on within the society so that the students, when they come out of the university can fit in and contribute*".

Thus, there is a general feeling from conducting this research that HEIs may have no choice in the matter and be forced to make some changes soon, if they are not already doing so. If they are to compete effectively, HEIs will need to offer more value for money spent on education. "*Older universities can perhaps afford to be complacent because they have built up a name and a following. Post-92 universities like us must continue to evolve to attract younger students and compete*", stated a content developer in a post-92 university.

A member of the governing board of same university agreed, adding: "education is user-driven and it is not about the media or technology, it is about what the user needs and the experience of learning". As the review of this thesis have found, students will likely demand more in future as universities increasingly become business organisations.

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Appendices

Appendix 1: Data collection plan

Illustrative representation of research data collection plan (sequential mixed methods approach – Cameron, 2009)

	Activities	Data / output
Literature / citation analysis / systematic review	• Current literature related to learning and ML from a variety of sources	• Coded texts and strands • Categorisation of themes • Critical reasoning / analysis • Missing data
Phase I: Quantitative survey	• Print / web-based survey	• Usage and perception data
Quantitative analysis	• Data screening, trend identification, pattern & theme matching	• Descriptive statistical data • Trends, patterns and themes • Missing data
Longitudinal / qualitative study design & participant selection	• Selection of participants for the studies & planning • Questions design • Consent administration	• Participants contacted / consent
Phase II: Survey / qualitative data collection	• Print / web-based survey • In-depth face-to-face / telephone interviews	• Audio recordings • Textual transcripts • Descriptive information
Qualitative / observations analysis	• Use of Atlas.Ti • Coding / thematic analysis • Theme development	• Coded texts and themes • Similarity & comparison of trends and themes; • Missing data / dissemination
Phase III: Longitudinal studies	• Observations / monitoring of sessions / tutorial / instances • Focus groups & interviews	• Experiences, perceptions, assumptions, inferences • Audio recordings & textual transcripts • Descriptive information
Longitudinal study / qualitative analysis	• Use of Atlas.Ti • Coding / thematic analysis • Theme development	• Coded texts and themes • Similarity & comparison of trends and themes; • Missing data / dissemination
Phase IV: Survey / qualitative data collection	• Print / web-based survey • In-depth face-to-face / telephone interviews	• Audio recordings • Textual transcripts • Descriptive information
Research data analysis / dissemination	• Interpretation / explanation of quantitative, qualitative & case data collection	• Conclusions and discussions • Recommendations • Missing data / dissemination

Appendix 2: Methodology and data gathering mapping

Research questions	Data collection methods
1. ***To what extent has ML using MDTs been integrated in learning and teaching in higher education since its conception?*** a) How can we theoretically understand ML as a concept? i. What are the pedagogical issues in implementing a ML process for adult learners? ii. What type of descriptive metaphors or definitions should be used to explain ML processes and ML content / resources? iii. How do educators' perceptions of the concept of ML affect integration of ML / using MDTs in their teaching practice?	• Existing literature (ML) • Qualitative data – interviews • Longitudinal study pre-service tutors • Observation of practices
b) How can theory be applied to ML using MDTs in educational processes? i. How abstraction modelling techniques of Requirement Engineering (RE) and Agent Oriented Software Engineering (AOSE) inform learning design decisions and integration for ML and MDTs integration in educational processes? ii. How do you design, organise, present and / or create content for different types of MDTs in a BYOD environment with emphasis on mobility and adaptability; and what are the implications for network security? iii. What ML content types are best suited for different learning goals? iv. How do educators' decisions regarding ML and MDTs integration affect learners' use of MDTs in their learning?	• Existing literature (ML) • Existing literature (Abstract modelling techniques) • Qualitative data – interviews • Longitudinal study pre-service tutors • Longitudinal study – Freshers • Observation of practices
c) What are the effects of MDTs on the practice of ML in educational processes? i. How effective is the current learning content and instructional materials for ML and MDTs in educational processes? ii. How do educators apply heuristics, principles and templates to their own learning content and instructional materials?	• Qualitative data – interviews • Longitudinal study pre-service tutors • Observation of practices
d) What factors affect the integration of MDTs in educational processes and the implementation of ML? i. What are the methods of integration and implementation of ML? ii. How do learners interact differently with ML processes than they do with conventional / traditional learning?	• Secondary data on HE • Qualitative data – interviews • Longitudinal study – Freshers • Observation of practices
2. To what extent has the content and information available for use on MDTs been adapted to encourage seamlessness and continuity in the learning and utilisation process? a) How well are MDTs able to accurately recognise / interpret the information available in the learner's environment / context; and consequently trigger or encourage learning?	• Existing literature (ML) • Qualitative data – interviews • Longitudinal study – Freshers • Observation of practices
3. If ML as a theoretical practice and learning type is not to remain consigned in obscurity, how can we encourage a merging of theoretical and practice-based understanding of the concept that informs future undertakings? a) How can ML and the integration of MDTs be improved in educational processes?	• Qualitative data – interviews • Longitudinal study pre-service tutors • Observation of practices

Research questions	Data collection methods
b) How do we educate instructors and tutors on how to incorporate adaptability and mobility into their learning contents and instructional materials using designing principles, heuristics and templates for MDTs?	
Several HEIs have prioritised provision of robust wireless networks, BYOD policies to support a myriad of MDTs and / or free issue of tablet PCs to students; most commonly new enrollees. ***4. What are the evidences supporting the effectiveness of HEIs' integration approach and in the promotion of ML?***	• Secondary data on HE • Qualitative data – interviews • Observation of practices
a) Is HEI's approach in integration of ML using MDTs in learning and teaching the best way to address the issues?	
5. What evidence is there to support the need for framework for ML?	• Existing literature (ML) • Qualitative data – interviews • Observation of practices
a) Are there any evidence of the impact of ML framework application in current implementations and on integration and sustainability of ML using MDTs in learning and teaching?	
b) How valid is the argument that applying a framework to ML in HEI is the right approach in integrating and sustaining ML using MDTs in learning and teaching?	
c) Among proposed frameworks that has been supported with empirical testing evidence, which is the most likely to produce long term integration and sustainability?	
Evolution relationship between educational entities and MDT advancements seem in one direction; with technology driving development and appropriation in education. ***6. What is the nature of the evolution relationship between education and MDTs in a learning process?***	• Existing literature (ML) • Qualitative data – interviews • Observation of practices
a) How might integration of ML using MDTs in learning and teaching be impacted by education driving progression and advances in the manufacture of MDTs?	

Appendix 3: Systematic review results

Answers to research questions

As well as the main question to be answered by the study, there were several sub-questions, categorised into two main groups: practice-based questions and conceptual / theoretical questions. The following sections detail findings relating to these questions.

To what extent has MDTs been integration in educational processes since its conception?

It is clear more ML activities exist in schools and secondary education than in HEIs. Over 4,000 publications were excluded on IEEE Xplore, 1,882 in EBSCOhost when schools and secondary education keywords were applied as exclusion keywords. Of the 287 ML instantiation projects in HEIs, 113 are based in Asia, 69 in Europe, 23 in Australia, 37 in Africa and the remaining 45 from other countries / continents.

One of the 4 large scale projects involving other HEIs are international collaborations; 1 from Europe, and the other 2 from the US. All were funded privately through organisations, one by Sony Ericcson. All the large scale projects are no longer running.

Devices used (Code: mlearning-state(WMD&tools))

The table below lists the devices used in this practices:

	Code: mlearning-state(WMD&tools)
Devices	**Number of projects**
Students' own devices	112
PDAs	93
iPod / MP3 player	23
iPhone	22
Other	21
Smartphones	11
Laptop	5
Total	**287**

Institutional strategies (Code: mlearning-valueadded(strategies))

In all but one of the HEIs, no mention is made of overall strategies / policies for ML integration. An account of a project in Stanford University (US) described strategies to integrate mobile devices led at institutional level. These strategies involved provision of wireless infrastructures as well as ongoing training and support for mobile device use. However, 2 HEIs in Australia reported provision of training for staff and students prior to project initiation.

Pedagogy and the learning process (Code: mlearning-state(pedagogy))

Over 50% of the 287 projects are focused on informal learning scenarios i.e. students downloading learning content and studying on their own. Many of these projects were provisions of podcasts of lectures for students' mobile devices. 37% involved creation of interactive learning applications / games tested by a group of students. All cases involve formal as well as informal learning sessions.

Scaffolding technique was used in one of the projects while several seem to favour experiential learning techniques and prioritise relinquishing control to learners. All SMS messaging sessions occurred in formal traditional session settings.

Answers to practice-based questions

What factors influence successful integration of MDTs in educational processes?

The following are codes of driver factors for successful MDTs integration in educational processes:

Code	Description	Quotation count
mlearning-drivers(benefits-learners)	Evidence of benefits for learners	437
mlearning-exemplars(WMDuses)	Usage driven by usage examplars	343
mlearning-drivers(learners'preferences)	Learner preferences	197
mlearning-drivers(dead_time)	Dead time recovery	94
mlearning-drivers(access/demand)	Ready access and demand for use	61
mlearning-exemplars(research/trials)	Usage driven by research examplars	61
mlearning-drivers(benefits-studentteacher)	Evidence of benefits in student / teacher relationship	33
mlearning-drivers(benefits-disabled)	Evidence of benefits for the disabled	14
mlearning-exemplars(locale-specific)	Usage driven by locale specific examplars	9
mlearning-drivers(benefits-learning)	Evidence of benefits to the learning process	5
mlearning-drivers(locale-specific)	Usage driven by locale specific needs	5
mlearning-drivers(govt/inst'l policies)	Government / institutional policies	0

What barriers impede successful integration of MDTs in educational processes?

The following are codes of barriers impeding successful integration of MDTs in educational processes:

Code	**Description**	**Quotation count**
mlearning-issues(general)	General issues (not categorised)	400
mlearning-issues(definitions)	Issues relating to definitions in general	306
mlearning-issues(devicelimitations)	Issues relating to device limitations	174
mlearning-issues(transformation-needfor)	Issues relating to the need for transformation	174
mlearning-issues(collaborative/community)	Issues relating to collaborative / community practices	99
mlearning-issues(potential/disruption)	Issues relating to potential disruption	89
mlearning-issues(sustainability)	Issues relating to sustainability	66
mlearning-issues(evaluation)	Issues relating to evaluation	61
mlearning-issues(pedagogy/learning)	Issues relating to pedagogy in general	38
mlearning-issues(value-added)	Issues relating to value added	38
mlearning-issues(informal)	Issues relating to informal learning	28
mlearning-issues(staff-related)	Staff related issues	28
mlearning-issues(laptop/similar)	Issues relating to laptops	24
mlearning-issues(personalised)	Issues relating to personalised learning	24
mlearning-issues(definitions-needfor)	Issues relating to the need for clear definitions	19
mlearning-issues(frameworks)	Issues relating to frameworks	19
mlearning-issues(usabilitytesting)	Issues relating to usability testing	19
mlearning-issues(institution support)	Issues relating to institution support	9
mlearning-issues(disability/accessibility)	Issues relating to disability / accessibility	5
mlearning-issues(pedagogy-lackof)	Issues relating to lack of pedagogy	5
mlearning-issues(student-related)	Student related issues	5

What evidence exists through practices on impacts / influences on teaching and learning processes?

Code	**Description**	**Quotation count**
mlearning-drivers(benefits-learners)	Evidence of benefits for learners	447

Code	Description	Quotation count
mlearning-trends(transformation)	Evidence of learning transformation	80
mlearning-valueadded(evidence-feedback)	Feedback evidence	38
mlearning-drivers(benefits-studentteacher)	Evidence of benefits in student / teacher relationship	33
mlearning-valueadded(evidence)	Value-added evidence	33
mlearning-valueadded(evidence-learninggain)	Evidence of learning gain	9
mlearning-drivers(benefits-learning)	Evidence of benefits to the learning process	5

What frameworks or benchmarking methodologies have practices been based?

The MOBIlearn consortium project is a large-scale implementation spanning several countries and sectors. This project used the task model proposed by Taylor et al (2006) (pp. 307-308, 324-326). None of the remaining practices indicate framework(s) or any benchmarking methodology(ies) as its basis.

What are the influential characteristics of implementations / practices e.g. types of institutions / countries of origin / educational levels etc?

Details provided are sketchy on types of institutions and other characteristics surrounding the implementations. However, of the 287 projects, 113 are from Asia, 69 from Europe, 23 from Australia, 37 from Africa and the remaining 45 from other countries / continents. Educational levels range from first year undergraduates to Masters level students.

<u>Answers to conceptual and theoretical questions</u>

What is the current understanding of the concept of ML?

This question was examined by obtaining evidence to the following four sub-questions:

- ***What studies have been carried out to support this understanding?***
- ***What types of research methods are used in these studies?***
- ***What data collection methods are used in these studies?***
- ***What are the findings of these studies?***

Conceptual understanding of ML is not explicitly stated in many of the cases. However, many assume in general that any learning process involving the use of mobile devices can be assumed to be ML. For instance, all 87 projects involving the use of podcasts and 113 projects involving SMS messaging are describe as ML; same as those involving learning on field trips, problem-based simulations and augmented reality.

Clearly, a distinction should be made between these instances. For instance, the question may be asked about the mobility involved in SMS messaging within a formal learning session or indeed, the educational affordance employed in downloading audios of lectures to mobile devices? As far as the former is concerned, students are still very much tethered in a traditional learning process. In the latter, mobile device was only used as delivery tool and there seem to be no pedagogic involvement in achieving any learning gain that may occur.

In many of the cases, a mixed method of inquiry is used: questionnaire before experimental trial testing an implantation. A few of the projects relied entirely on pre- and post- test questionnaires while some also collected and analysed qualitative data from the subjects. All the projects with no exception reported some benefit added to the learning process. Some of the smaller projects in the large scale implementations reported some classroom disruptions and the need to consider funding sources to sustain the projects.

Is there a differentiation between e-learning and ML evident in conceptual understanding / practices (Code: mlearning-state(MLvEL))?

There were 80 quotations for this code found within the projects publications, and all went to great lengths to suggest the differences and similarities between ML and elearning in general. Several believe elearning may be characterised by ready access and connections to a wide range of subject domains while ML may be limited to situated, contextual problem-solving scenarios only.

Many agree *mobility* and *ubiquity* are key differences between the two and a few believe ML may be an extension of elearning or enhancement for elearning processes.

What are the contributory characteristics informing the conceptual understanding / practices of ML (Code: mlearning-state(definition) and mlearning-issues(definitions))?

One of the main characteristic informing the conceptual understanding / practices of ML is likely based on the understanding held about the concept of ML. This understanding will likely arise from the ML definition held in context. Issues relating to ML definitions are not short of interest. There were 306 quotations on issues relating to definitions; those proposing new ones often suggesting a rationale based on the lack of consensus. A total of 118 definitions were proposed in 859 documents, some re-cited several times but counted only once. Some of these issues, along with some of the definitions proposed have been discussed in several sections within this thesis.

Appendix 4: Hard / soft goals for institutional alignment with ML system

Table 1: Elicited requirements and goals from stakeholders, mapped to the categories in ML evaluation criteria and indicators in Table 2.6

Categories	Requirements
Content & curriculum in MDT-friendly environment / student-centered learning	Tick-box' / exam result agenda avoidance
	Transformational opportunities provision
	Learning spaces, social & robust
Institution / organisation's responsibilities - Integration, sustainability and governance	High-calibre / renowned academics engagement with undergraduates
	Immersion & dissemination of innovation
	Financial performance element reduced
	Programme options & delivery, flexible
	Example-led teaching in technology use
	MDT use encouraged through rewards and removal of fear factor
	Evolve to attract young students
	BYOD support system robust
	Barriers to progression removed
	Learner-centered learning encouraged
	Rigid classroom learning discouraged
	Knowledge society agenda
	Skilled / professional crafts leading to jobs prioritised
	Sharing good practice formal, joined-up strategies
	Innovation & infrastructure provision without excessive capital outlay
	Infrastructure provision-led motivation
	Technological development involvement
Instructional design in MDT-friendly environment / student-centered learning	Enhanced, rich, enjoyable, engaging learning experience the norm
	Technology use only for educational purposes
	Technology use in teaching and learning not promotional / performance-based
	Programme delivery, flexible
	Developments in technology innovates curriculum etc. knowledge up-to-date
	Needs / wants of students accurately understood & satisfied
	Rounded individuals developed, contributing to society
	TEL / collaborative / interactive / engaging teaching enabled
MDT users: Staff (instructors and support staff) and students' - Needs requirement analysis	Technological tools are accessible & benefits to learning & teaching translated
	Buy-in from staff & students in a downwards / upwards leadership approach
	Engagement & interest in own development
Mobile Device Technologies (MDTs) / infrastructures - Consider access, competencies & prefences for all users (staff, students and other stakeholders)	Fitness for purpose ensured in technology use
	24/7 access to the digital learning libraries
	Support provision for new academics from Schools and other educational levels
	NETtracy & technology competency skills
	Opinions sought on technology use in teaching & learning
	Learning support staff prioritise students' needs in staff development options
	Access to information & learning seamless
	Time & space for innovative discussions
Risk analysis and	Pilot / testing of initiatives thorough

Categories	Requirements
management, including impact	Learning apps, testing for relevance before use
	Beta / gamma testing of new technology for network interoperability
	Trainee teachers as change agents
	Collaborative / high-quality partnership to keep costs down
The learning space for MDT-friendly environment / student-centered learning	Learning platform easy to use, available 24/7, trusted, robust and environment
	Learning spaces, mobile for collaboration & reflection

Table 2: Code descriptions for all goals (soft and hard) used in the models presented in Chapter 7

***Gxxx** codes are potential functional goals (hardgoals); some are expressed in soft goal terms* ***Hxxx** codes are attributes that can hurt ML systems* ***Rxxx** codes are potential resources for ML systems*	
Code	***Description of softgoal***
G010	High level student admissions
G020	High HEI reputation & status
G030	High level staff & student loyalty
G040	Student satisfaction, loyalty & engagement & HEI reputation status high
G050	High quality teaching & learning
G060	Student success rate higher than benchmark
G070	Transformational opportunities consistently prioritised as publicised
G080	High quality spaces for teaching & learning
H081	Teaching & learning opportunities limited to classroom / timetabled meetings
G090	Innovative & scholarly teaching & learning offerings as publicised
G100	Capability for innovation & commitment to excellence activities
G110	Regular ample opportunities for ideas incubator / brainstorming
G120	Time allowance for pilot testing of ideas and obtaining buy-in before launch
H121	Little / no opportunities for ideas brainstorming & pilot testing
G130	New innovations arising from regular review / evaluation of practices
G140	Highly customisable & scalable digital mobile learning spaces
R141	Engaging: collaboration; knowledge construction; learning immersion, reflection, interpretation, analysis, application etc
R142	Authentic: with various opportunities for application of new knowledge to real world solutions; integration of problem-based & knowledge-based instructions
R143	Measurable: with continuous reflective evaluation of instructional design & delivery
H141	Restricted & limiting learning spaces
H142	Prohibiting costs, economic downturn, government policy, external factors etc
G150	Flexible options for a more distributed, mobile & time-conscious market
H151	Options restricted by curriculum / policy constraints
G160	Programmes delivered at times & places to suits learner
H161	Programmes in traditional / fixed timetabling structures devoid of flexibility & seamlessness
G170	Integrate innovative technology in learning and teaching
G180	Ongoing support for effective use of innovative technologies
R181	Deploy robust & innovative technological infrastructure & network platforms
R182	Seamless access to learning platforms across devices and networks
R183	Learning / content deployable on variety of devices, platforms, multiple operating systems etc.
H181	WiFi connectivity patchy or nonexistent

Gxxx codes are potential functional goals (hardgoals); some are expressed in soft goal terms ***Hxxx** codes are attributes that can hurt ML systems* ***Rxxx** codes are potential resources for ML systems*	
Code	***Description of softgoal***
H182	Incompatible network platforms & environment
H183	Device (or BYOD) support haphazard or nonexistent
H184	Restricting learning content / platforms / systems
G190	Timely & anticipatory satisfaction of students' needs & requirements
H191	Needs & requirements not established or satisfied successfully in a timely or anticipatory manner
G200	High level of expertise / competencies among staff & students on effective use of innovative technologies
H201	Little / no competency training on effective use of technologies
G210	Quality innovative technology competency training
G220	Accurate data on students' needs
H221	Inaccurate / irrelevant / unreliable data on students' needs & requirements
R221	Adequate time allowed for needs satisfaction (staff & students)
R222	Adequate time allowed time for expertise / competencies development (staff & students)
G230	Barriers to progression removed
G240	High quality student centered teaching & learning
G250	High rate of learner achievement, development & growth
G260	High number of breakaway students (less dependent on structures – Engeström 1996) relative to current student population
G270	High employability & career prospects
H271	Little / no opportunities for application of new knowledge to real world solutions
R271	High number of student interactions with world communities building networks
R272	Competitiveness in employment
R273	Range of collaborative / high-quality partnerships
G271	Increase sharing of good practices and dissemination of innovative findings / activities

Appendix 5: Comparison survey questionnaire

Mobile Device Technologies (MDTs): survey of usage in learning – Educators

Mobile device technologies in learning – survey

Purpose of questionnaire:
Bluetooth and WiFi connectivity; and the availability of increasingly powerful and sophisticated mobile devices and technologies have increased speculations on their potentials in education. This questionnaire aims to capture educators' views regarding the use of these devices in learning and their future in education. The information gathered from this questionnaire will help determine the factors and drivers for mobile learning in education. This will provide a basis for discussions about using mobile learning as part of efforts to transform educational processes.

Anonymity:
Names and personal identifying details are not required on this form.

Terminologies:
Please note that references to "mobile device" or "device" denote Bluetooth or WiFi enabled ubiquitous device technologies or similar (handheld, wearable or mobile). The terms "Ubiquitous mobile learning" and "mobile learning" is used in this survey to refer to the practice of learning using mobile device technologies (or learning away from normal – situated – locations e.g. field trips, informal or self-directed learning etc.).

***Mobile devices include:** Mobile phones, Personal Digital Assistant (PDA), Smartphones, Nintendo and other wearable or portable gaming device used for learning, iPods and MP3 players, iPad or similar and Notebooks, Tablet PCs, laptops or similar*

There are 29 questions in this survey

A Use* of devices in learning and teaching

1. Are you currently using* mobile device(s) in your teaching? *(Please choose only one)*

- Yes (Please go to Section B)
- No (Please continue from Question 2)

---

2. Have you ever used* mobile device(s) within your teaching? *(Please choose only one)*

- Yes (Please continue from next question)
- No (Please go to Section C)

(* Mobile device uses may include: feedback support on learning, practice exercises / activities to aid retention, activities as part of learning in a blended learning approach, facilitation of peer / group discussion etc. ... but may not include administrative uses such as sending reminders or information about classroom changes etc., to students)

3. Please tell us why you stopped using (or have never used) devices in your teaching. *(Please select all that apply)*

- ☐ Limited or lack of funding
- ☐ There was never an opportunity

☐ Mobile learning is not actively supported by / promoted in my institution

☐ No exemplar / good practice guidelines

☐ Costs too much to develop materials

☐ Takes too long / too much time and effort to develop materials

☐ It causes disruption and makes classroom management difficult

☐ It does not add notable value to student learning

☐ It does not add notable value to learning processes

☐ I don't believe it can help transform education

☐ Other (please specify below)

(Please go to Section C)

B Description of current uses in learning and teaching

From your experience of using mobile devices in your teaching, please select the best option(s) to complete the statement below?

4. Mobile devices are effective ____________________________.

Please choose only one of the following:

- in all learning contexts
- in some learning contexts only

Please choose only one of the following:

- in certain subjects only
- in all subjects

Please choose only one of the following:

- only when devices can be provided for students
- only when students can provide own devices
- in either case, provided it is sustainable

Please choose only one of the following:

- only with learners that have no easy access to education
- only with learners that are experts in the use of technology
- with all types of learners regardless of profile or demographic, when used appropriately

Please choose only one of the following:

- only in informal learning
- only in collaborative learning
- in varying types of learning modes (blended)
- only in traditional (face-to-face) sessions

● only in distance / correspondence learning

5. How are you using mobile device(s) in your teaching? (*Please tick as applicable)*

I encourage / facilitate students to …	Mobile phones (not PDAs & Smart phones)	Personal Digital Assistant (PDA) / Smart phones	Nintendo / gaming devices	iPods / MP3 / digital recorders etc	iPad or similar	Notebooks / Tablet PC / laptops	ebook readers
access web-based learning materials and online services.	●	●	●	●	●	●	●
use SMS messaging to interact with tutor about learning.	●	●	●	●	●	●	●
Use SMS messaging to interact with other students / peers.	●	●	●	●	●	●	●
record information about learning for use later.	●	●	●	●	●	●	●
participate in group learning activities.	●	●	●	●	●	●	●
Other types of uses (Please explain below)	●	●	●	●	●	●	●

***Please** to explain*

6. If the mobile device(s) used is not shown above, please specify below.

7. Number of modules within which mobile devices are used for teaching and learning.
modules / subject units

8. Why did / do you use mobile device(s) in your teaching? *(Please select all that apply)*

☐ The institution provided devices to students

☐ Students used their own devices

☐ I obtained internal funding to use device(s)

☐ I obtained external funding to use device(s)

☐ The institution supported and encouraged the use mobile devices in learning

☐ There were awareness sessions and institution-led culture change for mobile learning

☐ I was inspired by champion, early adopters and sharing good practice schemes

☐ Institution provided IT resources and support for mobile content development

☐ It supports / enhances students' learning overall

☐ It motivates students to study on their own

☐ It supports / encourages collaborative learning

☐ It supports / encourages self-directed learning

☐ It provides quick / convenient access to information

☐ Other tutors / colleagues recommend using it

☐ Using devices make it easier to achieve learning objectives

☐ Using devices could increase gains in learning

☐ Other (please specify below)

C Drivers and barriers for use

9. Are any of your students using mobile devices in their learning? *(Please choose only one)*

- Yes (Please continue from Question 10)
- No (Please go to Question 11)
- Don't know (Please go to Question 11)

10. Please describe how your students are using mobile devices briefly below.

11. Please rate each of the following *(1 for <u>most serious</u> and 5 for <u>least serious</u>)*.

	Enter rating (1, 2, 3, 4 or 5)
Lack of WiFi or Bluetooth connectivity.	
Lack of supporting technologies / software.	
Inadequate IT support in institution for use in learning.	
Device battery life.	
Multiple screen sizes / networks / operating systems.	
Changes in design models / functionalities.	
Keyboard (input device) difficult to use.	
Expense of suitable devices.	
Limited accessibility & ongoing running cost.	
Limited file types / formats supported by devices.	
Bandwidth too low for non-stop / fast streaming.	
Information takes too long to download to device.	
Learning materials not available for devices.	
Modifying existing learning materials for devices.	
Teaching not designed for ML.	
Learning disruption & classroom management issues.	
Students' inability to use devices effectively.	
Devices used inappropriately within learning sessions (e.g. cyber bullying etc.).	
Inadequate learning support out of sessions.	
Lack of tracking / results for proper use.	
Intrusion / disruption to students' personal time / space.	
Ethical issues relating to data protection.	
Ethical issues relating to privacy.	
Security and copyright issues.	
Potential health risks.	
Potential exposure to virus attack.	
Other (please give details below).	

What is your opinion on the benefit(s) of using mobile devices in the following contexts?

In the far left and right columns are phrases to complete the statements below. These represent some opposing views about some contextual mobile device usage.

Please complete the statement by placing a tick in the cell(s) closest to the phrase reflecting your opinion in each row. If you are unsure, please select the middle column (N = Neutral).

12. Providing revision materials and feedback support via mobile devices (e.g. by SMS texting or mobile applications) ________________________.

	Agree	Neutral	Agree	
increases students' success rate in assessments	⬣	⬣	⬣	makes no difference to students' success rate in assessments
annoys students and intrudes on students' privacy	⬣	⬣	⬣	has little / no effect on students' privacy
is useful and helpful to students overall in learning	⬣	⬣	⬣	is not useful or helpful to students overall in learning
encourages students to seek further support when needed	⬣	⬣	⬣	makes no difference to seeking further support
increases students' expenses and costs	⬣	⬣	⬣	makes no difference to students' finances
is not preferred to class tutorials / revision classes	⬣	⬣	⬣	is preferred to class tutorials / revision classes
is needed in addition to tutorials / revision classes	⬣	⬣	⬣	is not needed in addition to tutorials / revision classes

13. Providing course / lecture materials for mobile devices ________________________.

	Agree	Neutral	Agree	
increases understanding of topic	⬣	⬣	⬣	makes no difference to understanding of topic
forces learners' to buy / finance expensive devices	⬣	⬣	⬣	makes no difference to learners' reasons for buying devices
makes no difference to people with no suitable devices	⬣	⬣	⬣	is unfair to people with no suitable devices
encourages learners to study anywhere at any time (make better use of free time)	⬣	⬣	⬣	makes no difference to learners' private study patterns
is needed in addition to VLE or LMS and other content management system	⬣	⬣	⬣	is not needed in addition to VLE or LMS etc
is not preferred to VLE or LMS content	⬣	⬣	⬣	is preferred to VLE or LMS content

14. Using mobile devices in learning activities ________________________.

	Agree	Neutral	Agree	
makes learning interesting and motivating	⬣	⬣	⬣	has no effect on learning processes
makes learning process more effective	⬣	⬣	⬣	makes no difference to the effectiveness of learning processes
can positively transform learning processes	⬣	⬣	⬣	can negatively transform learning processes
cannot disrupt learning processes	⬣	⬣	⬣	can be disruptive to learning processes
makes classroom management more difficult	⬣	⬣	⬣	makes classroom management easier
gives control to learners in learning processes	⬣	⬣	⬣	makes no difference to learner control
gives more control to tutors in learning processes	⬣	⬣	⬣	makes no difference to tutor control
can be too much in addition to all other technologies used in learning	⬣	⬣	⬣	cannot be excluded from the technologies used in learning

15. Please rate each of the following *(1 for <u>most beneficial</u> and 5 for <u>least beneficial</u>)*.

	Enter rating (1, 2, 3, 4 or 5)
Competing with other institutions / colleagues.	
Introducing new technology to learners / learning.	

	Enter rating (1, 2, 3, 4 or 5)
Portability / ‘wear’ ability of mobile devices.	
Enables effective use of ‘dead’ / idle time.	
Can positively enhance / support learning processes.	
Can support students with special needs.	
Can motivate hard to reach students.	
Provide access to information in remote locations.	
Just in time or provision of further learning support.	
Timely communication with students / peers.	
Quick access to learning content / materials for students.	
Quick access to social networking sites / email etc., for students.	
Enables location-based / contextual learning.	
Other (please give details below).	

D Content and learning delivery

16. Which of these technologies do you currently use in your teaching? *(Please select all that apply)*

- ☐ Powerpoint & downloadable materials
- ☐ Twitter
- ☐ Interactive web activities / online applications
- ☐ Social networking sites
- ☐ Blogs, wikis and similar
- ☐ Multimedia & other similar resources
- ☐ Podcasts, video casts and similar
- ☐ 2D / 3D Virtual Worlds & simulations
- ☐ Other (please specify):

17. Do you make your teaching materials available for mobile devices? *(Please choose only one)*

- Yes (Please go to Question 19)
- No (Please continue from Question 18)

18. Please tell us why you don’t. *(Please select all that apply)*

- ☐ There was never an opportunity to do so.
- ☐ Costs too much to develop materials for mobile devices.
- ☐ Takes too much time / effort to develop materials for mobile devices.
- ☐ Platforms, networks, device screen size / functionalities etc too varied and always changing.
- ☐ No technical support provided by institution for content development.
- ☐ My students do not require mobile content in addition to what they have.
- ☐ Other (***please specify below***):

19. Which of the following should be made available to support mobile content development and usage in learning? *(Please select all that apply)*

- ☐ IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs).
- ☐ Staff development training on content delivery and ML.

- ☐ Mobile learning project collaborations across institutions.
- ☐ Champions and early adopters sharing good practice.
- ☐ Awareness sessions and institution-led culture change.
- ☐ Funding support for ML projects.
- ☐ Other (***please specify below***):

20. Do you think students would prefer that educators make course materials available for mobile devices? *(Please choose only one)*

- Yes (Please continue from Question 21)
- No (Please go to Section E
- Don't know (Please explain below and go to Section E)

21. Which of these devices should course materials be made available for? *(Please select all that apply)*

- ☐ Mobile phones (not PDAs & Smartphones)
- ☐ iPad or similar
- ☐ Nintendo / gaming devices
- ☐ Notebooks / Tablet PC / laptops
- ☐ iPods / MP3 / digital recorders etc
- ☐ ebook readers (e.g. Kindle)
- ☐ Personal Digital Assistant (PDA) / Smartphones
- ☐ Other (**please specify**):

E Teaching details

22. Please enter your main subject / discipline(s) area below:

23. Time spent teaching in an average week (hours). *(Please choose only one)*
hours

24. Length of teaching experience (in years). *(Please choose only one)*

- less than 5
- 5-15
- 16-25
- 25+

25. Type(s) of learners taught? (Please select all that apply)

- ☐ Learners attending face to face sessions
- ☐ Distance learners
- ☐ Online learners
- ☐ Correspondence learners

26. Educational sector *(Please choose only one)*

- Compulsory education and Schools
- Further education and colleges
- Higher education
- Other (please specify below)

27. Do you have other concerns about the use of mobile device in learning and teaching? *(Please explain your answer in the space provided)*

- Yes (Please explain below)
- No (Please explain below)
- Don't know (Please explain below)

28. Please use this space to make any further comments.

29. Please enter your country below:

Thank you very much for taking part in this study.

If you've received this in print form, would like to be updated on the results or require further information, please send an email to r.olasoji@uel.ac.uk for a reply paid envelope.

END OF SURVEY

Mobile Device Technologies (MDTs): survey of usage in learning – Learning support and governance

Mobile device technologies in learning – survey

Purpose of questionnaire:
Bluetooth and WiFi connectivity; and the availability of increasingly powerful and sophisticated mobile devices and technologies have increased speculations on their potentials in education. This questionnaire aims to capture educators' views regarding the use of these devices in learning and their future in education. The information gathered from this questionnaire will help determine the factors and drivers for mobile learning in education. This will provide a basis for discussions about using mobile learning as part of efforts to transform educational processes.

Anonymity:
Names and personal identifying details are not required on this form.

Terminologies:
Please note that references to "mobile device" or "device" denote Bluetooth or WiFi enabled ubiquitous device technologies or similar (handheld, wearable or mobile). The terms "Ubiquitous mobile learning" and "mobile learning" is used in this survey to refer to the practice of learning using mobile device technologies (or learning away from normal – situated – locations e.g. field trips, informal or self-directed learning etc.).

***Mobile devices include:** Mobile phones, Personal Digital Assistant (PDA), Smartphones, Nintendo and other wearable or portable gaming device used for learning, iPods and MP3 players, iPad or similar and Notebooks, Tablet PCs, laptops or similar*

There are 18 questions in this survey

A Evaluation of current uses in learning and teaching

Concerning current uses of mobile devices in learning context(s), please select the best option(s) to complete the statement.

1. Mobile devices are effective _____________________________.

Please choose only one of the following:

- in all learning contexts

- in some learning contexts only

Please choose only one of the following:

- in certain subjects only
- in all subjects

Please choose only one of the following:

- only when devices can be provided for students
- only when students can provide own devices
- in either case, provided it is sustainable

Please choose only one of the following:

- only with learners that have no easy access to education
- only with learners that are experts in the use of technology
- with all types of learners regardless of profile or demographic, when used appropriately

Please choose only one of the following:

- only in informal learning
- only in collaborative learning
- in varying types of learning modes (blended)
- only in traditional (face-to-face) sessions
- only in distance / correspondence learning

B Drivers and barriers for use

2. Are you or anyone you know using mobile devices in learning context(s)? *(Please choose only one)*

- Yes (Please continue from Question 3)
- No (Please go to Question 4)
- Don't know (Please go to Question 4)

3. Please describe uses of mobile devices briefly below.

4. Please rate each of the following *(1 for <u>most serious</u> and 5 for <u>least serious</u>)*.

	Enter rating (1, 2, 3, 4 or 5)
Lack of WiFi or Bluetooth connectivity.	
Lack of supporting technologies / software.	
Inadequate IT support in institution for use in learning.	
Device battery life.	
Multiple screen sizes / networks / operating systems.	
Changes in design models / functionalities.	
Keyboard (input device) difficult to use.	
Expense of suitable devices.	
Limited accessibility & ongoing running cost.	

	Enter rating (1, 2, 3, 4 or 5)
Limited file types / formats supported by devices.	
Bandwidth too low for non-stop / fast streaming.	
Information takes too long to download to device.	
Learning materials not available for devices.	
Modifying existing learning materials for devices.	
Teaching not designed for ML.	
Learning disruption & classroom management issues.	
Students' inability to use devices effectively.	
Devices used inappropriately within learning sessions (e.g. cyber bullying etc.).	
Inadequate learning support out of sessions.	
Lack of tracking / results for proper use.	
Intrusion / disruption to students' personal time / space.	
Ethical issues relating to data protection.	
Ethical issues relating to privacy.	
Security and copyright issues.	
Potential health risks.	
Potential exposure to virus attack.	
Other (please give details below).	

What is your opinion on the benefit(s) of using mobile devices in the following contexts?

In the far left and right columns are phrases to complete the statements below. These represent some opposing views about some contextual mobile device usage.

Please complete the statement by placing a tick in the cell(s) closest to the phrase reflecting your opinion in each row. If you are unsure, please select the middle column (N = Neutral).

5. **Providing revision materials and feedback support via mobile devices (e.g. by SMS texting or mobile applications) _______________________.**

	Agree	Neutral	Agree	
increases students' success rate in assessments	●	●	●	makes no difference to students' success rate in assessments
annoys students and intrudes on students' privacy	●	●	●	has little / no effect on students' privacy
is useful and helpful to students overall in learning	●	●	●	is not useful or helpful to students overall in learning
encourages students to seek further support when needed	●	●	●	makes no difference to seeking further support
increases students' expenses and costs	●	●	●	makes no difference to students' finances
is not preferred to class tutorials / revision classes	●	●	●	is preferred to class tutorials / revision classes
is needed in addition to tutorials / revision classes	●	●	●	is not needed in addition to tutorials / revision classes

6. **Providing course / lecture materials for mobile devices _______________________.**

	Agree	Neutral	Agree	
increases understanding of topic	●	●	●	makes no difference to understanding of topic
forces learners' to buy / finance expensive devices	●	●	●	makes no difference to learners' reasons for buying devices
makes no difference to people with no suitable devices	●	●	●	is unfair to people with no suitable devices
encourages learners to study anywhere at any time (make better use of free time)	●	●	●	makes no difference to learners' private study patterns
is needed in addition to VLE or LMS and other content management system	●	●	●	is not needed in addition to VLE or LMS etc
is not preferred to VLE or LMS content	●	●	●	is preferred to VLE or LMS content

7. Using mobile devices in learning activities _________________________.

	Agree	Neutral	Agree	
makes learning interesting and motivating	●	●	●	has no effect on learning processes
makes learning process more effective	●	●	●	makes no difference to the effectiveness of learning processes
can positively transform learning processes	●	●	●	can negatively transform learning processes
cannot disrupt learning processes	●	●	●	can be disruptive to learning processes
makes classroom management more difficult	●	●	●	makes classroom management easier
gives control to learners in learning processes	●	●	●	makes no difference to learner control
gives more control to tutors in learning processes	●	●	●	makes no difference to tutor control
can be too much in addition to all other technologies used in learning	●	●	●	cannot be excluded from the technologies used in learning

8. Please rate each of the following *(1 for <u>most beneficial</u> and 5 for <u>least beneficial</u>)*.

	Click below to select rating
Competing with other institutions / colleagues.	
Introducing new technology to learners / learning.	
Portability / 'wear' ability of mobile devices.	
Enables effective use of 'dead' / idle time.	
Can positively enhance / support learning processes.	
Can support students with special needs.	
Can motivate hard to reach students.	
Provide access to information in remote locations.	
Just in time or provision of further learning support.	
Timely communication with students / peers.	
Quick access to learning content / materials for students.	
Quick access to social networking sites / email etc., for students.	
Enables location-based / contextual learning.	
Other (please give details below).	

C Content and learning delivery

9. In your opinion, which of the following should be made available to support mobile content development and usage in learning and teaching? *(Please select all that apply)*

- ☐ IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs).
- ☐ Staff development training on content delivery and ML.

- ☐ Mobile learning project collaborations across institutions.
- ☐ Champions and early adopters sharing good practice.
- ☐ Awareness sessions and institution-led culture change.
- ☐ Funding support for ML projects.
- ☐ Other (***please specify below***):

10. Do you think students would prefer that educators make course materials available for mobile devices? *(Please choose only one)*

- Yes (Please continue from Question 11)
- No (Please go to Section E
- Don't know (Please explain below and go to Section E)

11. Which of these devices should course materials be made available for? *(Please select all that apply)*

- ☐ Mobile phones (not PDAs & Smartphones)
- ☐ iPad or similar
- ☐ Nintendo / gaming devices
- ☐ Notebooks / Tablet PC / laptops
- ☐ iPods / MP3 / digital recorders etc
- ☐ ebook readers (e.g. Kindle)
- ☐ Personal Digital Assistant (PDA) / Smartphones
- ☐ Other (**please specify**):

D About you

12. Please describe your role in learning & teaching support or governance.

13. Gender *(Please choose only one)*

- Male
- Female

14. Percentage of your week spent supporting / governing learning & teaching (on average) *(Please choose only one)*

- less than 10%
- 10-25%
- 26-50%
- 51-75%
- Over 75%

15. Educational sector *(Please choose only one)*

- Compulsory education and Schools
- Further education and colleges
- Higher education
- Other (please specify below)

16. Do you have other concerns about the use of mobile device in learning and teaching? *(Please explain your answer in the space provided)*

- Yes (Please explain below)
- No (Please explain below)
- Don't know (Please explain below)

17. Please use this space to make any further comments.

18. Please enter your country below:

Thank you very much for taking part in this study.

If you've received this in print form, would like to be updated on the results or require further information, please send an email to r.olasoji@uel.ac.uk for a reply paid envelope.

END OF SURVEY

Mobile Device Technologies (MDTs): survey of usage in learning – Students

Mobile device technologies in learning – survey

Purpose of questionnaire:
Bluetooth and WiFi connectivity; and the availability of increasingly powerful and sophisticated mobile devices and technologies have increased speculations on their potentials in education. This questionnaire aims to capture educators' views regarding the use of these devices in learning and their future in education. The information gathered from this questionnaire will help determine the factors and drivers for mobile learning in education. This will provide a basis for discussions about using mobile learning as part of efforts to transform educational processes.

Anonymity:
Names and personal identifying details are not required on this form.

Terminologies:
Please note that references to "mobile device" or "device" denote Bluetooth or WiFi enabled ubiquitous device technologies or similar (handheld, wearable or mobile). The terms "Ubiquitous mobile learning" and "mobile learning" is used in this survey to refer to the practice of learning using mobile device technologies (or learning away from normal – situated – locations e.g. field trips, informal or self-directed learning etc.).

Mobile devices include: *Mobile phones, Personal Digital Assistant (PDA), Smartphones, Nintendo and other wearable or portable gaming device used for learning, iPods and MP3 players, iPad or similar and Notebooks, Tablet PCs, laptops or similar*

There are 28 questions in this survey

A Use* of devices in learning

1. Are you currently using* mobile device(s) in your learning? ***(Please choose only one)***

- Yes (Please go to Section B)
- No (Please continue from Question 2)

---

2. Have you ever used* mobile device(s) in your learning? ***(Please choose only one)***

- Yes (Please continue from next question)
- No (Please go to Section C)

(* Mobile device uses may include: feedback support on learning, practice exercises /

activities to aid retention, activities as part of learning in a blended learning approach, facilitation of peer / group discussion etc. ... but may not include administrative uses such as receiving reminders or information about classroom changes etc.)

3. Please tell us why you stopped using (or have never used) devices in your learning. ***(Please select all that apply)***

☐ Unable to afford the cost of suitable device

☐ Unable to afford the ongoing running cost

☐ There was never an opportunity

☐ Mobile learning is not actively supported by / promoted in my institution

☐ Costs too much to download learning content

☐ Takes too long / too much time to download learning content

☐ I believe it causes disruption and makes classroom management difficult

☐ My tutor(s) believe it causes disruption and makes classroom management difficult

☐ It does not add notable value to student learning

☐ It does not add notable value to learning processes

☐ I don't believe it can help transform education

☐ Other (please specify below)

(Please go to Section C)

B Description of current uses in learning and teaching

From your experience of using mobile devices in your learning, please select the best option(s) to complete the statement below?

4. Mobile devices are *most effective* when used ___________________________.

Please choose only one of the following:

● in all learning contexts

● in some learning contexts only

Please choose only one of the following:

● in certain subjects only

● in all subjects

Please choose only one of the following:

● only when devices can be provided for students

● only when students can provide own devices

● in either case, provided it is sustainable

Please choose only one of the following:

● only with learners that have no easy access to education

● only with learners that are experts in the use of technology

● with all types of learners regardless of profile or demographic, when used appropriately

Please choose only one of the following:

● only in informal learning

● only in collaborative learning

● in varying types of learning modes (blended)

● only in traditional (face-to-face) sessions

● only in distance / correspondence learning

5. How are you using mobile device(s) in your learning? (*Please tick as applicable)*

I use mobile devices to …	Mobile phones (not PDAs & Smart phones)	Personal Digital Assistant (PDA) / Smart phones	Nintendo / gaming devices	iPods / MP3 / digital recorders etc	iPad or similar	Notebooks / Tablet PC / laptops	ebook readers
access web-based learning materials and online services.	●	●	●	●	●	●	●
use SMS messaging to interact with tutor about learning.	●	●	●	●	●	●	●
Use SMS messaging to interact with other students / peers.	●	●	●	●	●	●	●
record information about learning for use later.	●	●	●	●	●	●	●
participate in group learning activities.	●	●	●	●	●	●	●
Other types of uses (Please explain below)	●	●	●	●	●	●	●

***Please** to explain*

6. If the mobile device(s) used is not shown above, please specify below.

7. 7. On how many modules / subject units have you used mobile devices to support your learning.

modules / subject units

8. Why did / do you use mobile device(s) in your learning? *(Please select all that apply)*

☐ The institution provided devices to students

☐ I have and used my own devices

☐ Mobile devices are commonly used to support learning in my institution

☐ My institution has awareness sessions for mobile learning

☐ My institution provided IT resources and support for mobile learning / devices

☐ It supports / enhances students' learning overall

☐ It motivates me to study on my own (anywhere and at any time)

☐ It helps when learning with others

☐ It helps me organise my learning

☐ It provides quick / convenient access to materials for my learning

☐ My tutors / colleagues recommend using it

☐ Using devices make it easier to achieve success in my assessments

☐ Other (please specify below)

C Drivers and barriers for use

9. Are any of your colleagues / friends using mobile devices in their learning? *(Please choose only one)*

● Yes (Please continue from Question 10)

● No (Please go to Question 11)

● Don't know (Please go to Question 11)

10. Please describe how they are using mobile devices briefly below.

11. Please rate each of the following *(1 for <u>most serious</u> and 5 for <u>least serious</u>)*.

	Enter rating (1, 2, 3, 4 or 5)
Lack of WiFi or Bluetooth connectivity.	
Lack of supporting technologies / software.	
Inadequate IT support in institution for use in learning.	
Device battery life.	
Multiple screen sizes / networks / operating systems.	
Changes in design models / functionalities.	
Keyboard (input device) difficult to use.	
Expense of suitable devices.	
Limited accessibility & ongoing running cost.	
Limited file types / formats supported by devices.	
Bandwidth too low for non-stop / fast streaming.	
Information takes too long to download to device.	
Learning materials not available for devices.	
Learning materials not designed for ML.	
Learning disruption & classroom management issues.	
Inability to use devices effectively.	
Devices used inappropriately within learning sessions (e.g. cyber bullying etc.).	
Inadequate learning support out of sessions.	
Lack of tracking / results for proper use.	
SMS texts etc. / disruption to students' personal time / space.	
Ethical issues relating to data protection.	
Ethical issues relating to privacy.	
Security and copyright issues.	
Potential health risks.	
Potential exposure to virus attack.	
Other (please give details below).	

What is your opinion on the benefit(s) of using mobile devices in the following contexts?

In the far left and right columns are phrases to complete the statements below. These represent some opposing views about some contextual mobile device usage.

Please complete the statement by placing a tick in the cell(s) closest to the phrase reflecting your opinion in each row. If you are unsure, please select the middle column (N = Neutral).

12. Providing revision materials and feedback support via mobile devices (e.g. by SMS texting or mobile applications) ______________________.

	Agree	Neutral	Agree	
helps me succeed in assessments	●	●	●	makes no difference to my success in assessments
annoying and intruding on my privacy	●	●	●	has little / no effect on my privacy
is useful and helpful to me overall in learning	●	●	●	is not useful or helpful to me overall in learning
encourages me to seek further support when needed	●	●	●	makes no difference to seeking further support
increases my expenses and costs	●	●	●	makes no difference to my finances
is not preferred to class tutorials / revision classes	●	●	●	is preferred to class tutorials / revision classes
is needed in addition to tutorials / revision classes	●	●	●	is not needed in addition to tutorials / revision classes

13. Providing course / lecture materials for mobile devices ______________________.

	Agree	Neutral	Agree	
increases understanding of topic	●	●	●	makes no difference to understanding of topic
forces me to buy / finance expensive devices	●	●	●	makes no difference to my reasons for buying devices
makes no difference to people with no suitable devices	●	●	●	is unfair to people with no suitable devices
encourages me to study anywhere at any time (make better use of free time)	●	●	●	makes no difference to my private study patterns
is needed in addition to VLE or LMS and other content management system	●	●	●	is not needed in addition to VLE or LMS etc
is not preferred to VLE or LMS content	●	●	●	is preferred to VLE or LMS content

14. Using mobile devices in learning activities ______________________.

	Agree	Neutral	Agree	
makes learning interesting and makes me want to learn more	●	●	●	has no effect on how I feel about learning
makes learning process more effective	●	●	●	makes no difference to the effectiveness of learning processes
can change learning processes for the better	●	●	●	cannot change learning processes for the better
cannot disrupt learning processes	●	●	●	can be disruptive to learning processes
makes classroom management more difficult	●	●	●	makes classroom management easier
gives control to learners in learning processes	●	●	●	makes no difference to learner control
gives more control to tutors in learning processes	●	●	●	makes no difference to tutor control
can be too much in addition to all other technologies used in learning	●	●	●	cannot be excluded from the technologies used in learning

15. Please rate each of the following *(1 for <u>most beneficial</u> and 5 for <u>least beneficial</u>)*.

	Click below to select rating
Competing with other institutions / colleagues.	
Gaining new skills using new technologies.	
Portability / ‘wear’ ability of mobile devices.	

	Click below to select rating
Enables effective use of 'dead' / idle time.	
Can positively enhance / support learning processes.	
Can motivate hard to reach students.	
Can support students with special needs.	
Provide access to information in remote locations.	
Just in time or provision of further learning support.	
Timely communication with students / peers.	
Quick access to learning content / materials for students.	
Quick access to social networking sites / email etc., for students.	
Enables location-based / contextual learning.	
Other (please give details below).	

D Content and learning delivery

16. Which of these technologies do you currently use in your learning? *(Please select all that apply)*

- ☐ Powerpoint & downloadable materials
- ☐ Interactive web activities / online applications
- ☐ Blogs, wikis and similar
- ☐ Podcasts, video casts and similar
- ☐ Twitter
- ☐ Social networking sites
- ☐ Multimedia & other similar resources
- ☐ 2D / 3D Virtual Worlds & simulations
- ☐ Other (please specify):

17. Would you prefer that tutors make course materials available for mobile devices? *(Please choose only one)*

- Yes (Please go to Question 20)
- No (Please continue from Question 18)

18. Do you think some students would prefer that educators make course materials available for mobile devices? *(Please choose only one)*

- Yes (Please continue from Question 19)
- No (Please go to Section E)
- Don't know (Please explain below and go to Section E)

19. Which of these devices should course materials be made available for? *(Please select all that apply)*

- ☐ Mobile phones (not PDAs & Smartphones)
- ☐ Nintendo / gaming devices
- ☐ iPods / MP3 / digital recorders etc
- ☐ Personal Digital Assistant (PDA) / Smartphones
- ☐ iPad or similar
- ☐ Notebooks / Tablet PC / laptops
- ☐ ebook readers (e.g. Kindle)
- ☐ Other (**please specify**):

E About you

20. Please enter your main subject / discipline(s) area below:

21. Gender *(Please choose only one)*

- Male
- Female

22. Age *(Please choose only one)*

- Under 21
- 21-30
- 31-40
- 41-50
- 50+

23. Percentage of week spent studying *(Please choose only one)*

- less than 10%
- 10-25%
- 26-50%
- 51-75%
- Over 75%

24. Programme status – learning mode (Please select all that apply)

- [ ] Face to face sessions
- [ ] Distance learners
- [ ] Online learners
- [ ] Learning by correspondence

25. Educational sector *(Please choose only one)*

- Compulsory education and schools
- Further education and colleges
- Higher education
- Other (please specify below)

26. Do you have other concerns about the use of mobile device in learning and teaching? *(Please explain your answer in the space provided)*

- Yes (Please explain below)
- No (Please explain below)
- Don't know (Please explain below)

27. Please use this space to make any further comments.

28. Please enter your country below:

Thank you very much for taking part in this study.

If you've received this in print form, would like to be updated on the results or require further information, please send an email to r.olasoji@uel.ac.uk for a reply paid envelope.

END OF SURVEY

Appendix 6: Interview question topics

ML proponents / experts / practitioners: Interview topics (main)

Topics:

1. Participant demographics, including job title, role / responsibilities in educational processes and / or governance as well as details of ML activities (past and present). (Names and other specific identifying information will not be recorded but identification may be possible through details provided.)
2. ML definition
3. Impressions / opinions on the standard of ***known*** ML state of the art (practices / implementations / activities – past and present)
4. Perception of HEI’s approach / efforts (if any) in integration of ML
5. Progression in education / student demographics in line with social transformation
6. ML content / materials
7. Guidelines / framework models for ML practices
8. ML future / improvement suggestions
9. Other / general (related) / concluding (follow-up) questions / topics

Educational theorists / practitioners: Interview topics (main)

Topics:

1. Participant demographics
2. Progression in education – general (emphasis on HE)
3. Progression in education – student demographics in line with social transformation
4. Preparation of future educators – teacher training
5. Impact of MDTs on educational processes
6. Evaluation of current educational system - disciplines
7. Perception on HEI’s approach / efforts (if any) in the integration and the future of MDTs in HE
8. Personal take on ML as a practice
9. Future of MDTs integration in HE ....
10. General (related) concluding questions

Educational governance: Interview topics (main)

Topics:

1. Participant demographics
2. Progression in education – general
3. Progression in education – student demographics in line with social transformation
4. Preparation of future educators – teacher training
5. Impact of MDTs on educational processes
6. Perception of HEI’s approach / efforts (if any) in the integration and the future of MDTs in HE
7. Personal take on ML
8. General / concluding questions / topics

Appendix 7: Focus group scenarios and guiding questions

Scenarios:

Mr Pitt
Scenario subject parameters
Age: May be assumed to be between 27-35
Discipline: Non-technical subject
Support for ML: May be assumed to support ML
Experience: In-service tutor

Mr Pitt has just begun a PGCE programme at a UK university. He has a 1st degree in Geography and a Masters degree in Geology. Although Mr Pitt was born in the UK, his first language is not English because parents relocated to Africa when he was young. He returned to the UK 10 years ago and began teaching in a Secondary School in the East end of London 3 years later. Mr Pitt's teacher education is funded through the Secondary School and he will be carrying out his teaching practice with colleagues he's worked with for the last 7 years.

Mr Pitt will be teaching Geography and Biology during his teaching practice. He has used several online technologies in his teaching before and has become the "go to" person for help on some technical aspects of integrating technology where he works, regularly participating in sharing good practice events. Mr Pitt would generally ban students from using their mobile devices in his classroom in the past but is now re-thinking his stand on this issue. He has recently attended a conference on ML and using MDTs in learning where he was informed of the potential benefits and is currently giving it some consideration.

Miss Brimstone
Scenario subject parameters
Age: May be assumed to be between 18-26
Discipline: Technical subject
Support for ML: May be assumed to support / be knowledgeable about ML but reluctant to use in teaching
Experience: Pre-service tutor

Miss Brimstone completed her 3-year undergraduate study in Computing has just begun a PGCE programme at a UK university. During her undergraduate studies, she regularly used her mobile device to access learning content online and love playing games to pass the time on her mobile device(s). She has recently purchased an iPad which she uses regularly during her lectures. Miss Brimstone has never taught before and will be teaching for the first time during her teaching practice in a local Secondary School. She has attended training on integrating technologies in general into her teaching and is looking forward to using interactive whiteboards and some online learning tools / applications.

Miss Brimstone will be teaching Computing and ICT during his teaching practice. Although she has used MDTs in her studies and has an iPad, she intend to only use them during her teaching practice for storing her teaching materials and files only. This is because she believes mobile devices has no place in the classroom and should only be used for games and can be disruptive. She is also concerned about the inequality that may result from students using different devices with a variety of platforms and network connections to access learning content. From her experience during her own studies in the university, she noticed there were several in her group unable to access learning content the way she could.

Mrs Buttercups
Scenario subject parameters
Age: 35-45
Discipline: Non-technical subject
Support for ML: No knowledge of technology but supports ML
Experience: Pre-service tutor

Mrs Buttercups is in her early 30s and has just begun a PGCE programme at a UK university planning to teach Languages in schools. Mrs Buttercups would generally shy away from using technologies because she believes she is not very good with them. However, she is convinced of their benefit and in the past, wish she was more confident with using them. She recently attended a training session on integrating technologies in general into her teaching with Miss Brimstone. She now has some confidence using some technologies.

While she agrees with Miss Brimstone about the inequality that may result from students using different devices with a variety of platforms and network connections, she believes these problems could be overcome and plan to give it a try. She however believes there must be a good learning case for their use in teaching. Mrs Buttercups have done some private tutoring briefly before but she has never taught in a school or a formal environment.

Scenario summaries:

Scenario 1: Mr Pitt

Age: Between 27-35 years old
Discipline: Non-technical subject
Nationality: Born in the UK but relocated out when young … returned 10 years ago
Qualification: 1st degree in Geography / Masters in Geology
Teaching subject(s): Geography & Biology
Experience: In-service tutor (7 years)
Considered the "go-to" person for Tech among colleagues
Used several online technologies in his teaching before
Support for ML:
Would generally ban students from using their mobile devices in his classroom
Pro/con: Now re-thinking stand … after attending a Technology Enhanced Learning (TEL) conference

Scenario 2: Miss Brimstone

Age: Between 18-26 years old
Discipline: Technical subject
Nationality: Born in the UK and have lived in the UK always
Qualification: First degree in Computing; PGCE Secondary ongoing
Teaching subject(s): Computing and ICT
Experience: Pre-service tutor; no previous teaching experience
Support for ML:
Knowledgeable about ML (owned & used iPad for teaching administration and during first undergraduate study)
Attended a TEL event recently
Keen to use interactive whiteboards and some online learning tools
Pro/con: Reluctant to use MDTs in teaching … Believes mobile devices have no place in the classroom … only a toy and can be disruptive
Concerned about the inequality that may result from students using different devices …. with a variety of platforms and network connections to access learning content

Scenario 3: Mrs Buttercups

Age: Between 36-45 years old
Discipline: Non-technical subject
Nationality: Born in the UK and have lived in the UK always
Qualification: First degree in Languages
Teaching subject(s): Languages
Experience: Pre-service tutor; brief period of private tutoring but never taught in a school / formal environment
Support for ML:
Convinced of their benefit and in the past
Wish she was more confident with using them
Attended a TEL event … now feel she may re-consider …
Pro/con: Would generally shy away from using technologies because ….
…. believes she is not very good with them
Would only use if there is a good learning case for their use in teaching

Guiding questions:

1. *How are educators trained to utilize new technologies to improve teaching and learning?*
2. *How are training institutions ensuring that pre- and in-service teachers receive adequate and ongoing training about ML?*
3. *How do mobile technologies build the capacities of teachers and support their work with students?*

(UNESCO, 2013)

Results:

Table 1: Pre-service study (discussions on scenario subjects - 1)

Participants' comments	
Computing group	
October focus group study (before the first placement)	
[Mr Pitt] *(1) I think he and the older woman [Mrs Buttercups] might be scared to use technology in their teaching.* *(2) There has been a change of attitude over the last 10 years and many teachers are using mobile technologies more …* *[Miss Brimstone]* *(1) No experience of teaching but she knows how to use mobile technologies …* *(2) She is worried about inequalities … but actually, the issue of inequality does not matter these days. I think it is more about how comfortable I am with the device I have … It doesn't matter if anyone has a different device.* *(3) I think she is right to worry but it may be more to do with finding out how make sure there is not problem … no one is disadvantaged.* *[Mrs Buttercups]* *She is keen … that's good. She will get over her fear once she starts to use it more.*	
February focus group study (after the first placement)	
Computing group	Modern languages group
[Mr Pitt] *(1) I think it [his background] would have an impact because … the thing with using mobile phones is you have to be really firm … Because it is something which can distract the kids as well as help them so you need to think about behaviour as well.* *(2) He is older with several years teaching experience so we may assume he will be comfortable with using mobile technologies.* *(3) He may have felt uncomfortable before but he may be more accepting now after attending the conference and possibly finding out some of the benefits of using them …* *[Miss Brimstone]* *(1) She is right to think playful element to using mobile device. But that could help the lesson and make the students more attentive … so it could be ok as long as you control the lesson and you prepare. It might make for a better lesson.* *(2) I don't agree [with Miss Brimstone] there's inequality. Most smartphones are quite sophisticated these days and they have the same sort of apps.* *(3) I think it also depend on how you prepare for*	*[Mr Pitt]* *(1) I think some of us are exactly in that situation. We are a bit older, facing a career change … and I think in that situation, you have to go with the flow. You made the decision to go into teaching for a variety of reasons and one of the skills we are being taught is to reflect and think: How can I do things better? That to me is fundamental to the profession. So, I think Mr Pitt is in that position and will need to reflect on his practice so far and think how to do things better. And it sounds like he is doing that.* *(2) If he's willing to embrace the rapid changes in technology then yes.* *(3) I think it may take some time for him to change his practice. He's been teaching for a long time and may have picked up a lot of traditional habits. So, if he hasn't been that exposed to technology, he'll find it hard to keep up the pace.* *(4) I think the fact he is teaching Geography can be a great motivator. Most phones have location aware apps and he may find those are very useful in his teaching.* *(5) I think mobile technology is wonderful for Geography because if I'm explaining about Africa for example, I can get the kids to check Google Earth on their phones in the classroom to see where that is*

Participants' comments	
Computing group	
October focus group study (before the first placement)	
your lesson as well. *[Mrs Buttercups]* *(1) She is more open to using technology but she may not be confident … She needs to make sure she is confident in using it effectively because if she is not confident, she won't be able to support her class* *(2) She will also need to learn more about the issues and what is available in her school.*	*and we could do some activities with that. They could use their camera to take pictures of places and upload it to Google Earth as an activity. They could use GPS on the phones and other stuffs.* *[Miss Brimstone]* *(1) I think she's right about inequality because not all the kids have all the latest equipment and with mobile phones it can be difficult if everyone's got different phones.* *(2) I don't think it is an issue in a place like England or developed countries.* *(3) She needs to know it is in the kid's best interest. They love these stuff and most want them. My year 11 come in each day and moan and say: It's boring. They find learning boring and don't want to come to school half the time. If they have more interesting lessons maybe they'll be happy to be in school. So she needs to be open minded and make sure the kids with top of the range devices don't get to boast about it.* *[Mrs Buttercups]* *<Comment on Mrs Buttercups' background was related to training>*
June focus group study (after the second placement)	
Computing group	Modern languages group
[Mr Pitt] *(1) Maybe he was reluctant to use technology as he was concerned with knowing what to do with technology for your subject or maybe the school didn't encourage him. Maybe there's renewed interest with other teachers around him or he's trying to attract their attention now.* *(2) I think it would have an impact because … the thing with using mobile phones is you have to be really firm … Because it is something which can distract the kids as well as help them so you need to think about behaviour as well.* *[Miss Brimstone]* *She has control over the inequality in her classroom. With my second placement, they all had this program and they all had this program on tablets regardless of their background as gifts and all you had to do was invest something at some point to get the iPad. Otherwise there would be some inequality. They used it as a replacement for the PC but also a lot of the work was given online so I guess that stemmed the need for tablets.* *[Mrs Buttercups]* *(1) It would depend on how she integrates it into her teaching* *(2) Low confidence which could improve with time.* *(3) She might be discouraged if she fails initially.* *(4) She might also deprive the students as there is so much technology around and she may get confused.*	*[Mr Pitt]* *(1) Google maps ... he could be interested now because of the subject he is teaching.* *(2) I think there's a difference in terms of knowing about it to actually delivering it. You need to have experience to deliver it so the pupils can connect.* *(3) He [Mr Pitt] needs to meet an objective as part of his lessons that has an education outcome of learning.* *[Miss Brimstone]* *(1) I agree with her. She's putting the children's needs first and realising potential dangers.* *(2) If she really believes ML will have positive outcomes then maybe she needs some encouragement.* *(3) Schools should have an induction to use the technology.* *(4) It's all about money. You can't just ask them to bring their phones in because other children will see it and rob them.* *[Mrs Buttercups]* *(1) It's never too late to learn.* *(2) I think the older you get there are challenges. It is a generation thing. Some generations, say people in their 60s and beyond, it's a challenge. Hence, why in a lot of schools and colleges there will be courses run for that generation. Just the basics to bring them up to date. I saw an add the other day that currently there are people in Barclays helping with technology because they don't use it in their day to day lives and are not familiar with it. So stuff like online banking etc. You can learn it you just need that infrastructure and support* *(3) I have an aunty that's 70 and she can use a computer.*

Table 2: Pre-service study (discussions on scenario subjects - 2)

Participants' comments	
Computing group	
October focus group study (before the first placement)	
[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups] *(1) The subject (or discipline) doesn't matter anymore…all subjects will be able to find some ways to use mobile technologies.* *(2) I think that the subject he [Mr Pitt] is teaching may make him even more accepting because Geography is about the exploration of location and the GPS functionality on mobile devices could be very useful.* *(3) I don't think the fact that he is teaching Geography matters … mobile technologies are so good now that it doesn't matter what you are teaching, you can always find a way to use it in your teaching.*	
February focus group study (after the first placement)	
Computing group	Modern languages group
[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups] *<No comment and no change to previous sessions opinion … Students were polled and all agree MDT can be useful in all subjects>*	*[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups]* *(1) Not really [subject doesn't matter]. It depends on the personality. If you are someone who want to use technology, you can always find some way to use it in your subject but it may be more effective in some subjects than others.* *(2) For example, I don't like using technology. And I think maybe it is because I'm computer illiterate. If I know more, I think I'll be different.* *(3) Yes I'm computer illiterate too but I always like learning new things and will try to learn and stretch myself.*
June focus group study (after the second placement)	
Computing group	Modern languages group
[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups] *<No comment and no change to previous sessions opinion … Students were polled and all agree MDT can be useful in all subjects>*	*[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups]* *<No comment and no change to previous sessions opinion … Students were polled and all agree MDT can be useful in all subjects>*

Table 3: Pre-service study (discussions on scenario subjects - 3)

Participants' comments	
Computing group	
October focus group study (before the first placement)	
[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups] *(1) The conference can be a taster but they will need to go away and look at feasibility. He [Mr Pitt] can't just say everyone bring out your mobile device in the classroom just because he [Mr Pitt] attended a conference. There is a lot more he will have to find out, like how to support his students …* *(2) Take computers which has been around for years now, even teaching with that can be difficult … You still have to attend training to use Moodle or other VLE [Virtual Learning Environment] … let alone mobile phones which are all different in features. So I think with any technology, you need more than just a conference to use it in teaching.*	
February focus group study (after the first placement)	
Computing group	Modern languages group
[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups] *(1) The lady [Mrs Buttercups] in the scenario need to spend some time with technology and*	*[Mr Pitt] / [Miss Brimstone] / [Mrs Buttercups]* *(1) No way! She [Mrs Buttercups] needs to take more training and do a lot of research on the*

Participants' comments	
Computing group	
October focus group study (before the first placement)	
become confident to use it first before trying it out in her teaching. My subject background is Psychology [originally] and then I took a few weeks conversion class in Computing. So I don't have a background of years of Computing experience so I struggle with getting things to work. When I was asked by my head of department to use Scratch [an online tool], I didn't know what it was so I avoided it. But she kept on at me, gave me a link to a tutorial … so I finally had to learn how to use it over Christmas and then I used it. But it was only after I'd learnt how to use it that I felt confident to stand in front of the class and use it with the students. And I probably wouldn't have used it if I wasn't made to. And I wouldn't use anything I don't know how to use because I'll look like an idiot if they ask me questions and I am not able to answer it. *(2) If I wasn't comfortable with any technology [like Mrs Buttercups], I wouldn't use it.* *(3) Sometimes, the problem is the schools computer network. What I find is that in my school, some classes are not set up for technology use. So, adaptability comes in here, you have to use other stuffs when there's not technology to back you up.*	*technology and how to use them in her teaching.* *(2) I feel confident using computers, but even then, there are certain aspects that I will not even attempt using it in my lesson without proper training, even with my confidence around computers. So I've stayed away from them. With someone who has no confidence to start with, it'll be even harder to try anything. She will need several months of training first.* *(3) I don't think I agree. I think she [Mrs Buttercups] may have done some training in IT already because IT is quite a critical component for teaching these days. You have to have some IT skills to start with before she got onto the PGCE programme I think. So I think all she may need to update herself on the latest technologies and find out how she may use them.* *(4) I don't think everyone have that much aptitude for technology. We were taught here how to use whiteboard but I still couldn't use it in my school until someone showed me again how to do it and even then I couldn't use it properly.*

Table 4: Pre-service study (discussions on scenario subjects - 4)

Participants' comments	
Computing group	
October focus group study (before the first placement)	
(1) It is not really about confidence. It is more about doing more to make sure the technology fits into the lesson. There are other factors ….. If you are asking people to use technology … it is something that everybody expects to use but you have to put a lot of thought into it to use it properly. There are many things that you have to think about, like the differences in devices and how to support them in the lesson *(2) The use of mobiles depend on individuals. Some students may not be comfortable with it and I will need to find out if my students want it and what they can do first.* *[The students seem to have misunderstood the question. When pressed further with clarification on the question asked one responded ...]* *(3) It is very useful for preparation and getting information. It is impossible to do anything without mobile technologies these days.* *[All nodded and agreed]*	
February focus group study (after the first placement)	
Computing group	Modern languages group
(1) You need to keep at it. If you could avoid something, you would. Think about it, if you are a qualified teacher, you'll have a full time-table and you wouldn't really have the time to try to learn other things. *(2) The curriculum is also changing. So I had to learn how to use several new technologies I didn't know before … but I had to, to prepare*	*(1) I agree [that it does build capacity], especially if you are a trainee teacher. It will help if there are standards, achievements and that can be part of your CPD (Continuing Professional Development.* *(2) That was why I became a teacher. It was because I was becoming stale in my previous profession in banking, I wasn't moving or being challenged or developing as an individual. So, I*

Participants' comments	
Computing group	
October focus group study (before the first placement)	
myself for each lesson … on YouTube and whatnot. But I did that because I had to, the curriculum … So it has helped me.	*personally feel very excited. I'll put my hand up and say I'm a real novice, but I want to learn and I'm looking forward to doing that.* *(3) I think it could but you cannot rely too much on technology.* *(4) If you want to keep up with the school kids of today, you need to keep up with technology.* *(5) You can't be a teacher today unless you are up on technology and it is not about just PowerPoint.* *(6) But it must be used constructively to achieve the learning objectives.*
June focus group study (after the second placement)	
Computing group	Modern languages group
(1) Yes *(2) Definitely* *(3) I think it certainly helped. Our mentors didn't really help. I would say they were looking to us sharing common practise with them. They wanted to see how we would blend it into our lessons ... due to us being Computing teachers. I think they're aware that there's newer things out there that they aren't using so they were interested to see what we were doing.*	*(1) Technology does enhance and I definitely appreciate that so I need to work harder on being on the ball and more familiar using technology.* *(2) Yes. I need to update myself because I have to be at the same level as the kids but I have to use it according to my practise and set the limits because I am the teacher.* *(3) I'll make an effort but the school should train us as well and give us time because we have a lot of responsibility as well.* *(4) Or give us training courses to invest in ourselves because I do think there's a barrier and a gap.*

Table 5: Pre-service study (discussions on scenario subjects - 5)

Participants' comments	
Computing group	
October focus group study (before the first placement)	
(1) I am more aware now of how mobile devices can be useful in teaching. There are more resources that can be useful in teaching … more technologies that can make things a lot easier. *(2) I know where to go to if I need more resources.* *(3) It will depend on my school and what is available or possible in my school. All my students may not have mobile phones.*	
February focus group study (after the first placement)	
Computing group	Modern languages group
(1) No. I think we could have done with some introductory sessions on using several technologies. I didn't know how to use several technologies and I was quite shy so it took me a long time to make friends and ask them for help. *(2) Some warning on what we may find would have helped as well.* *(3) I had to develop myself and learn all the things I needed to teach my lessons. I learnt how to use the YouTube, spreadsheet, database etc. I think it is down to you to learn how to use the technologies you need to use.* *(4) I know there are so many things we have to learn ourselves, but I still think the tutors could have thought us a bit more on how to use several technologies effectively before we went out to teach. We needed to be introduced to a sample of them and interactively use them … e.g. smartboard etc. We need to practice on*	*(1) I think the programme's great and our tutor is brilliant. But it's still not enough. We had training here and we also have mentors in the schools but I still don't feel confident to use the whiteboard in my school.* *(2) I think there should be more training on technology integrated more into the programme. Don't get me wrong, our tutor was great but we needed more time to practice with different types of technology and how to use them. We just learnt the theory and some of the benefits but we didn't really get to practice using them.* *(3) I agree. We were just given a lecture on TEL and given an assignment to do on using technologies in teaching. Nothing else.*

Participants' comments	
Computing group	
October focus group study (before the first placement)	
some of them …	

Appendix 8: Freshers survey questions

1. Gender
   O Male O Female

2. Nationality:

3. Which country did you live in for the last 5 years?

4. Programme of study

5. Study mode
   O Full time O Part time O Other

6. Age
   O Under 21 O 21-30 O 31-40 O 41-50 O 50+

Mobility, adaptability and flexibility in your learning could make it easier to achieve your learning objectives and achieve good grades.

7. Do you agree with this statement?
   O Yes O No O Don't know

8. Do you expect or would you like ***mobility, adaptability and flexibility*** on your programme of study?
   O Yes O No O Don't know

9. How can ***mobility, adaptability and flexibility*** be achieved in your learning (select all that apply)?

☐ Using interactive blackboard	☐ Good teaching	Using WiFi enabled:
☐ Using online applications	☐ Good learning materials	☐ Mobile phones
☐ Using social network sites	☐ Regular attendance	☐ Smartphones
☐ Using VLE*	☐ Learning anywhere/at anytime	☐ iPads / tablet PC
☐ Using emails and texts	☐ Learning with friends	☐ Laptops
☐ ***Other (please specify):***		

**VLE: Virtual Learning Environment e.g. Moodle, Blackboard*

10. Do you own a smartphone?
    O Yes (Go to 10a) O No (Go to 11)

    10a. How many?

11. Do you own a tablet PC (e.g. iPad)?
    O Yes (Go to 11a) O No (Go to 12)

    11a. How many?

12. What do you use your smartphone(s) or tablet PC for (select all that apply)?

☐ Making calls	☐ Downloading materials	☐ Completing assignments
☐ Texting / messaging	☐ Emailing / checking emails	☐ Completing learning activities
☐ Watching learning videos	☐ Interacting with friends	☐ Using learning apps
☐ Using the Internet when out	☐ Finding information	☐ Emailing/contacting your tutor
☐ Visiting social network sites	☐ Playing on games apps	☐ Emailing/contacting friends
☐ ***Other (please specify):***		

13. Do you *expect* to be allowed to use smartphones / tablet PC (e.g. iPad) for your learning?
    O Yes O No O Don't know

14. If allowed, would you use smartphones / tablet PC (e.g. iPad) for your learning?
    O Yes O No O Don't know

15. Please briefly tell us why or why not?

16. Do you have a disability that could be assisted by using technologies?
    O Yes (Go to 17) O No (Go to 18) O Don't know (Go to 18)

17. Apart from specialist ***assistive technologies*** (hardware and software), please indicate which of the devices below may also be useful (select all that apply):

☐ Mobile phones with WiFi / internet connection	☐ iPad / tablet PCs with WiFi / internet connection
☐ Smartphones with WiFi / internet connection	☐ Laptops with WiFi / internet connection
☐ ***Other (please specify):***	

18. Would you be willing to participate further in this study?
    O Yes (Go to 18a) O No (Go to 19)

18a. Please provide the following contact information for further study:

Student ID:		Mobile number:	
Email address:			

****Contact information provided will be used for contacting you and may be associated with the study data during analysis for differentiation <u>only</u>.***

19. Would you like to add anything else?

Appendix 9: Ethics approval

EXTERNAL AND STRATEGIC DEVELOPMENT SERVICES
uel.ac.uk/qa
Quality Assurance and Enhancement

UEL University of East London

Mrs Remy Olasoji
UEL Connect Staff
Room 327
University House
Stratford

Date: 13 September 2011

Dear Remy,

Project Title:	***UBIQUITOUS LEARNING IN HIGHER EDUCATION: A FUNCTIONAL FRAMEWORK***
Researcher(s):	***MOTUNRAYO OLUTOYIN REMY OLASOJI***
Supervisor(s):	***DR CHRISINA DRAGANOVA***

I am writing to confirm that the review panel appointed to your application have now granted ethical approval to your research project on behalf of University Research Ethics Committee (UREC).

Should any significant adverse events or considerable changes occur in connection with this research project that may consequently alter relevant ethical considerations, this must be reported immediately to UREC. Subsequent to such changes an Ethical Amendment Form should be completed and submitted to UREC.

Approval is given on the understanding that the 'UEL Code of Good Practice in Research' (www.uel.ac.uk/qa/manual/documents/codeofgoodpracticeinresearch.doc) is adhered to.

Yours sincerely,

Merlin Harries
University Research Ethics Committee (UREC)
Quality Assurance and Enhancement
Telephone: 0208-223-2009
Email: **m.harries@uel.ac.uk**

Docklands Campus, University Way, London E16 2RD
Tel: +44 (0)20 8223 3322 Fax: +44 (0)20 8223 3394 MINICOM 020 8223 2853
Email: r.carter@uel.ac.uk

Appendix 10: Consent form

Dear participant,

This research seeks the opinion of educators, students and those in role of learning & teaching support and / or governance to determine the drivers and barriers to the use of MDTs in learning processes. The data collected will be used solely for the purpose of research as part of MPhil / PhD programme at the University of East London, UK.

Your comments and responses to questions asked will be recorded. These recordings will be viewed and transcribed only by the research team and will never be disseminated publicly without your consent. Names and other specific identifying information will not be recorded but identification may be possible through details provided.

All data will be held securely and confidentially. As soon as all the written work for the research is completed, all data collected for the research will be destroyed securely and permanently.

No aspect of the research and data collection process poses any known risks to your health and your name will not be associated with the findings without express permission. If you have any questions not addressed by this consent form or require more information, please do not hesitate to contact Remy Olasoji by email (r.olasoji@uel.ac.uk) or via the address below. You will receive a copy of this form, which you should keep for your records.

Thank you very much for your time.

Yours faithfully

Researcher
(Contact telephone +44 (0) 20 8223 2349)

CONSENT STATEMENT:
I have read the above and agree to participate in this study. I give my permission to be recorded, under the terms outlined above. I understand that if I have any questions or concerns regarding this project I can contact the investigator at the above location or at the **University of East London, Docklands Campus, University Way, London E16 2RD**; Telephone +44 (0) 20 8223 2349.

___________________________________ ________________
(Participant's signature and date)

Appendix 11: Secondary data: Oracle study report

	North America	Europe	Asia-Pacific	Latin America	Middle East
Use a Smartphone	56%	57%	62%	74%	95%
Have a tablet	10%	7%	16%	19%	27%
Plan to purchase a tablet in the next 12 months	26%	38%	34%	59%	46%

Percentage of respondents who say their usage of the following has increased over the last 12 months:

Data	47%
Texts	41%
Call minutes	39%
Apps	38%

Source: http://www.oracle.com/us/industries/communications/oracle-communications-future-mobile-521589.pdf

Appendix 12: Trade-off analysis for conflict resolution

Table 1: Illustration of trade-off analysis for conflict resolution in ML system requirements using some of the quality dimensions listed in Table 7.4 for categorising non-functional requirements (NFRs) among stakeholders

		Functional requirements / stakeholders						Non-functional requirements (NFRs)*								
Goals		Students	Educators	Learning support	Governance	Government / global educational policies / acts	Device manufacturers	High performance	Efficiency	Responsiveness	Flexibility	Reliability	Access	Completeness	Infrastructure robustness	Competence
G050	Tick-box' / exam result agenda avoidance	✓	✓✓✓	✓	--	--	-	++		++						
G070	High-calibre / renowned academics engagement with undergraduates	✓✓✓	--	-	✓✓	✓	-	++			++	++		++		
G070	Transformational opportunities provision	✓✓✓	✓✓✓	✓	✓✓	✓✓✓	✓		++	++				++		
G080	Learning platform easy to use, available 24/7, trusted, robust and environment	✓✓✓	✓✓✓	✓✓✓	✓✓	-	✓✓✓	++					++		+++	
G090	Enhanced, rich, enjoyable, engaging learning experience the norm	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✓✓	-	++						++		
G090	Technology use only for educational purposes	--	✓	✓	--	-	--		++							
G100	Immersion & dissemination of innovation	-	--	✓✓	✓✓✓	✓	-	++	++							++
G100	Financial performance element reduced	✓✓	✓✓✓	✓✓	--	-	-	++						++		
G110	Fitness for purpose ensured in technology use	✓	✓✓✓	✓✓✓	✓✓	✓	-	++	+++							
G110	Technological tools are accessible & benefits to learning & teaching translated	✓✓	✓✓✓	✓✓✓	✓✓	-	✓✓		++			++	++		++	
G120	Buy-in from staff & students in a downwards / upwards leadership approach	✓✓✓	✓✓✓	✓✓✓	--	✓	-		+++	++						
G120	Pilot / testing of initiatives thorough	-	✓✓✓	✓✓	✓✓	-	✓✓	+	++							
G120	Learning apps, testing for relevance before use	✓✓	✓✓✓	✓✓✓	✓✓	-	-	++	++							
G120	Beta / gamma testing of new technology for network interoperability	-	✓✓✓	✓✓	✓✓	-	✓✓	+	++							
G140	Learning spaces, social & robust	✓✓✓	-	✓✓	✓✓✓	-	✓						++		++	
G140	Learning spaces, mobile for collaboration & reflection	✓✓✓	✓✓✓	✓✓	✓✓	-	✓✓✓				++				+++	
G150	Programme options & delivery, flexible	✓✓✓	--	--	✓✓✓	-	-			++	+++					
G160	Programme delivery, flexible	✓✓✓	--	--	✓✓✓	✓	-			++	+++					

Goals		Functional requirements / stakeholders						Non-functional requirements (NFRs)*								
		Students	Educators	Learning support	Governance	Government / global educational policies / acts	Device manufacturers	High performance	Efficiency	Responsiveness	Flexibility	Reliability	Access	Completeness	Infrastructure robustness	Competence
G160	24/7 access to the digital learning libraries	✓✓✓	-	✓✓	✓✓	-	✓✓			++	+++		+++		+++	
G170	Example-led teaching in technology use	✓✓✓	--	✓✓	✓	-	-									
G170	Developments in technology innovates curriculum etc. knowledge up-to-date	✓✓✓	✓✓✓	✓✓✓	✓	-	✓✓✓		+							+
G170	MDT use encouraged through rewards and removal of fear factor	✓✓	✓✓✓	✓✓	✓✓	-	✓✓✓		++							
G170	Evolve to attract young students	-	✓✓	✓✓	✓✓	-	-		++	++				++		
G180	BYOD support system robust	✓✓✓	✓✓	✓✓	✓✓	-	✓✓		+	++	+++					
G190	Support provision for new academics from Schools and other educational levels	-	✓✓✓	✓✓	✓✓	✓	-		++	++						
G200	NETtracy & technology competency skills	✓✓✓	✓✓✓	✓✓✓	✓✓	-	✓✓							+	++	+++
G200	Technology use in teaching and learning not promotional / performance-based	✓✓	✓✓✓	✓✓✓	✓✓	-	--	++	++							
G220	Opinions sought on technology use in teaching & learning	✓	✓✓✓	✓✓	✓✓	-	-		++	++						
G220	Needs / wants of students accurately understood & satisfied	✓✓✓	✓✓✓	✓✓✓	✓✓	--	-		++	++						
G220	Learning support staff prioritise students' needs in staff development options	✓✓✓	✓	✓✓✓	✓✓	-	-	++	++							
G230	Barriers to progression removed	✓✓✓	✓✓✓	✓	✓✓	✓✓✓	✓		++	++				++		
G240	Learner-centered learning encouraged	✓✓✓	--	✓✓	✓✓	✓✓	-			++	++					
G250	Engagement & interest in own development	--	✓✓✓	✓✓	-	-	-	++						++		
G260	Rigid classroom learning discouraged	--	--	--	✓✓	-	-			++	++					
G260	Rounded individuals developed, contributing to society	✓✓✓	✓✓✓	✓	✓✓	✓✓✓	✓		++	++				++		
G270	Knowledge society agenda	✓✓✓	✓✓	-	✓✓	✓✓✓	-		++					++		
G270	Skilled / professional crafts leading to jobs prioritised	✓✓✓	✓✓	-	✓✓	✓✓✓	-		++					++		
G271	Sharing good practice formal, joined-up strategies	-	--	✓✓	✓✓✓	✓	-	++	++							++
H142	Innovation & infrastructure provision without excessive capital outlay	-	-	-	✓✓✓	✓✓✓	-		++							
R141	Infrastructure provision-led motivation	✓✓	--	✓	✓✓	-	✓✓			++	++		++		++	

Goals		Functional requirements / stakeholders						Non-functional requirements (NFRs)*								
		Students	Educators	Learning support	Governance	Government / global educational policies / acts	Device manufacturers	High performance	Efficiency	Responsiveness	Flexibility	Reliability	Access	Completeness	Infrastructure robustness	Competence
R142	Technological development involvement	✓	--	✓✓✓	✓✓✓	-	--	+			++				+++	
R142	TEL / collaborative / interactive / engaging teaching enabled	✓✓✓	✓✓✓	✓✓	✓✓	-	✓✓✓	++							+++	
R182	Access to information & learning seamless	✓✓✓	✓	✓✓✓	✓✓	✓	✓						++			
R222	Time & space for innovative discussions	✓	✓✓✓	✓✓	--	-	-	++	++							+++
R271	Trainee teachers as change agents	✓	-	-	-	✓✓✓	✓✓✓			++				++		
R273	Collaborative / high-quality partnership to keep costs down	-	-	-	✓✓✓	✓✓	-		+++							

Appendix 13: Secondary data: UCISA's Higher Education Information Technology Statistics (HEITS) data (relevant information only)

		E-learning/learning technologies support unit information					
			Responsibilities				
	Mission groups	**E-learning Support unit?**	**VLE**	**Module development**	**Consultancy & training**	**Support & development of learning with mobile devices**	**Other**
University of Abertay Dundee	Million +		✓	✓	✓		
Anglia Ruskin University	Million +						
University of the Arts London	Other	✓	✓	✓	✓	✓	
Aston University	None	✓	✓				✓
University of Bath	1994 Group	✓	✓		✓	✓	✓
Bath Spa University	1994 Group	✓	✓		✓	✓	
University of Bedfordshire	Million +	✓	✓	✓	✓	✓	✓
Birkbeck, University of London	1994 Group	✓	✓		✓	✓	
University of Birmingham	Russell Group	✓	✓	✓	✓	✓	
University of Bradford	University Alliance	✓	✓	✓	✓	✓	
University of Brighton	None	✓	✓		✓	✓	
University of Bristol	Russell Group	✓	✓	✓	✓		
Brunel University	*n/k*	✓	✓		✓		
Buckinghamshire New University	Million +	×					
University of Cambridge	Russell Group	✓	✓		✓		
Canterbury Christ Church Univeristy	None	✓					
University of Central Lancashire	1994 Group	✓	✓		✓	✓	
The University of Chichester	None	✓	✓		✓	✓	✓
Coventry University	Million +	✓	✓				
Cranfield University	*n/k*	✓	✓				
University of Cumbria	Other	✓	✓	✓		✓	
De Montfort University	University Alliance	✓		✓			✓
University of Essex	1994 Group	✓	✓		✓	✓	✓
Glasgow Caledonian University	University Alliance	✓	✓			✓	✓

	Mission groups	E-learning/learning technologies support unit information					
			Responsibilities				
		E-learning Support unit?	VLE	Module development	Consultancy & training	Support & development of learning with mobile devices	Other
University of Gloucestershire	1994 Group	✓	✓		✓	✓	
University of Greenwich	Million +	✓			✓		
Heriot-Watt University	None	×					
University of Hertfordshire	University Alliance	✓	✓		✓	✓	✓
University of Kent	None	✓	✓	✓	✓	✓	✓
King's College London	Russell Group	✓	✓	✓	✓		
Kingston University (London)	Million +	✓	✓			✓	✓
Lancaster University	1994 Group	✓	✓	✓	✓	✓	
College of Law	None	×					
Leeds College of Art	*n/k*	✓	✓	✓	✓		
Leeds Metropolitan University	Million +	✓	✓	✓	✓	✓	
University of Liverpool	Russell Group	✓	✓		✓	✓	
University College London	Russell Group	✓	✓	✓	✓	✓	
London School of Economics and Political Science	Russell Group	✓	✓		✓	✓	✓
London School of Hygiene and Tropical Medicine	None	✓	✓		✓	✓	
Loughborough University	1994 Group	✓	✓				✓
University of Wales, Newport	University Alliance	✓	✓				
Newcastle University	Russell Group	✓	✓		✓	✓	✓
Newman University College	Other	✓	✓	✓			
Northumbria University	University Alliance	✓	✓	✓	✓		✓
University of Nottingham	Russell Group	✓	✓		✓		✓
University of Oxford	Russell Group	✓	✓		✓	✓	
University of the West of Scotland	*n/k*	✓	✓	✓	✓	✓	✓
University of Plymouth	University Alliance	✓				✓	✓
Queen Margaret University	None	✓	✓	✓	✓	✓	
Queen's University Belfast	Russell Group	✓	✓		✓	✓	✓
The University of Reading	1994 Group						
Roehampton University	*n/k*	✓	✓				

	Mission groups	E-learning/learning technologies support unit information					
		E-learning Support unit?	Responsibilities				
			VLE	Module development	Consultancy & training	Support & development of learning with mobile devices	Other
Royal Holloway, University of London	1994 Group	✓	✓	✓	✓	✓	✓
University of Stirling	None	✓	✓		✓	✓	✓
University of Strathclyde	None	✓	✓	✓	✓		
University of Surrey	1994 Group	✓	✓		✓		
University of Sussex	1994 Group	✓	✓		✓	✓	✓
University of Ulster	None	✓	✓		✓	✓	
Warwickshire College	None	✓	✓		✓	✓	
University of Westminster	None	✓	✓	✓	✓		
University of Wolverhampton	Million +	✓	✓		✓	✓	
Dublin Institute of Technology	None	✓	✓	✓	✓	✓	
NUI Galway	Other						
No. of responses	61	58	52	21	43	35	21

Source: *http://www.ucisa.ac.uk/bestpractice/surveys/statistics/2010.aspx*

Appendix 14: Comparison table for Mobile Learning (ML) frameworks

Corresponding indicator name / description represented by numbers in this table can be found in Table 2.6 in Section 2.3.5. A tick is placed in each indicator cell for a framework if the framework makes allowance / recognition for the indicator within the framework specification. No speculations have been made on implications not explicitly stated and the depth of accomplishment is not included. Details of abbreviations used to represent each framework can be found in Table 2 below, including other relevant details about each framework.

Table 1: ML frameworks comparison using indicators suggested in Table 2.6, Section 2.3.5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
MLFF	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
IMLF	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
CFUKC	✔	✘	✔	✔	✘	✘	✘	✘	✘	✘	✔	✔	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
MLM	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
EMLM	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
TMF	✔	✘	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
MCSCL	✔	✘	✘	✘	✔	✔	✔	✘	✘	✘	✘	✔	✔	✘	✔	✔	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
SLF	✔	✔	✔	✘	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
TESRML	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✔	✔	✔	✔	✘	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
SMSEID	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✘	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
FRAME	✔	✔	✔	✔	✘	✔	✘	✔	✔	✘	✘	✔	✘	✘	✘	✘	✔	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
SAMR	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘
IMWL	✔	✔	✔	✔	✘	✔	✘	✔	✔	✘	✔	✔	✔	✘	✘	✘	✘	✘	✘	✘	✔	✔	✔	✔	✘	✔	✔	✔	✘	✘	✔	✘
PEI	✘	✘	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✔	✔	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘	✘

Table 2: Brief description of the ML frameworks compared in Table 1

Abbreviations	Frameworks	Author(s) / reference(s)	Components	Comments	Tested / demonstrated?
MLFF	ML functional framework	Patten et al, 2006; cited in Clough et al, 2007	*Specifications for* Collaborative; Administration; Location aware; Data collection; Referential; Interactive; Microworld	This framework has sub-items and a version with specifies the pedagogic underpinning	Yes

Abbreviations	Frameworks	Author(s) / reference(s)	Components	Comments	Tested / demonstrated?
IMLF	Informal ML framework	Clough et al, 2007	Patten et al's framework specifying informal activities and contexts	An adaptation of Patten et al's (2006) framework model	Yes
CFUKC	The conceptual framework of ubiquitous knowledge construction	Patten	*Specifications for* Issues; Components & Functions		No
MLM	Shih's ML model	Shih & Mills, 2007; cited in Moses, 2008	*Specifications for* Multimedia Message (Attention); Simulated Gaming (Satisfaction); Digital Story Telling (Confidence); Web Search (Relevance); Peer to Peer Discussion (Relevance / Confidence)		Yes
EMLM	Enhanced Shih's ML model	Moses, 2008	*Adds* Posting of testimonials (Satisfaction); Online library search for e-books and audio books (Relevance) *to Shih's model*	An enhancement of Shih's (n.d.) model	No
TMF	The task model framework	Taylor et al, 2005; cited in Vavoula, 2005	*Specifications for* Technological tool; Subject; Object; Control; Context; Communication	The focus is the mobility in the technology used but the model was illustrated to reflect ML episodes in technological space in the MOBIlearn trials. Also used by Frohberg et al (2009) to classify ML projects	MOBIlearn

Abbreviations	Frameworks	Author(s) / reference(s)	Components	Comments	Tested / demonstrated?
MCSCL	The conceptual framework for mobile computer-supported collaborative learning	Zurita & Nussbaum, 2007	MCSCL activity specifying for Roles and rules; Network and Collaborative activity		Yes
SLF	The seamless learning framework	Looi et al, 2010	Private space *comprising of* learners, teachers and expert; Public space *comprising of* community; *linked with* Cognitive tools *which in turn links* time, space and artefacts *all within* Context		No
TESRML	Components of a taxonomy of educational situations and requirements for ML	Belshaw, 2010	Domain / educational components; Cognitive / social skills; Innovative educational practice; Learning tools and strategies; Contextual content & mobile technology support	Not strictly presented as a framework	No
SMSEID	**S**cenario, **M**essage, **S**ynchronisation and **E**valuation instructional design model	Shih, 2005	Scenario; Message; Synchronisation; Evaluation		Yes

Abbreviations	Frameworks	Author(s) / reference(s)	Components	Comments	Tested / demonstrated?
FRAME	The Framework for the Rational Analysis of Mobile Education model	Koole et al, 2010; cited in Belshaw, 2010	(D) Device aspect; (DL) Device usability; (DS) Social technology; (DLS) ML; (L) Learner aspect; (LS) Interaction learning; (S) Social aspect *within* Information context	Authors suggest further testing with larger sample required	Yes
SAMR	Puentedura's SAMR model	cited in Belshaw, 2010	Redefinition and Modification *for Transformation* and Augmentation and Substitution *for Enhancement*	www.hippasus.com/rrpweblog/archives/000025.html and hippasus.com/resources/tte/	Unknown
IMWL	JISC's model of implementation for mobile and wireless learning	JISC 2005; cited in Belshaw, 2010	Vision, Infrastructure, Culture, Learners *reflecting around* Innovative practice		No
PEI	Framework for prioritising ethical issues	Wishart, 2010; cited in Belshaw, 2010	Personal information, privacy & images; Informed consent; Ownership, Data storage & protection; User generated content *considered for 'Do good', 'Avoid harm', 'Respect user choice', 'Share resources fairly'* matrices		No

Appendix 15: Secondary data: Rated ML projects (Frohberg et al, 2009)

Name	Authors	Year	Context	Tools	Control	Communication	Subject	Objective
AmbientWood	Randell et al.	2004	Physical	3	3	3	1	4
Ask the Author	Deng et al.	2005	Formal	2	1	2	1	2
attaQ	Takenaka et al.	2006	Independent	2	1	3	1	1
BBC Bytesize	Thornton and Houser	2004	Independent	2	1	1	1	1
BirdWatching Learning System	Chen et al.	2003	Physical	3	3	2	1	2
BodyLearning	Noessel	2003	Physical	1	4	2	1	2
BSUL	Saito et al.	2005	Formal	2	1	3	1	2
ButterflyWatching Learning System	Chen et al.	2004	Physical	3	2	2	1	2
Caerus	Naismith et al.	2005	Physical	1	2	1	1	1
ClassTalk	Dufresne et al.	1996	Formal	2	1	2	1	2
Clls	Chen and Chou	2007	Physical	2	4	1	1	1
CLUE	Ogata and Yano	2004	Physical	1	5	1	1	1
Code It	Goldman et al.	2004	Independent	3	2	3	1	3
Code Talk	White	2006	Formal	3	2	4	1	3
Collaborative Note Taking	Singh et al.	2004	Formal	2	4	2	2	2
CropViewer	Wentzel	2005	Physical	3	2	2	2	2
DEEP	Traxler and Leach	2006	Independent	1	1	1	1	1
DFAQ	Ng'ambi	2005	Formal	2	1	2	1	2
Discourse	Naismith et al.	2005	Formal	2	1	2	1	2
EduClickII	Chen et al.	2005	Formal	2	1	2	1	2
Educue	Naismith et al.	2005	Formal	2	1	2	1	2
Eijiro	Morita	2003	Independent	2	1	1	1	1
Electronic Guidebook	Hsi	2002	Physical	2	2	1	1	3
Environmental Detectives	Squire and Klopfer	2007	Physical	2	2	3	1	3

Name	Authors	Year	Context	Tools	Control	Communication	Subject	Objective
eSchoolbag	Chang et al.	2003	Physical	2	2	4	1	1
Exploratorium	Hsi	2003	Physical	4	2	1	1	3
From e-learning to m-learning	Keegan	2002	Independent	1	1	1	1	1
ftf-CSCL	Cortez et al.	2005	Formal	3	3	4	1	3
Garden Explorer	Tarumi et al.	2007	Physical	2	2	2	1	1
Genius Loci	Noessel	2003	Physical	2	2	1	1	1
Geometric Game	Ketamo	2002	Independent	1	1	1	1	1
Gipsy	Wentzel	2005	Physical	3	2	2	2	2
Group Scribbles	Brecht et al.	2006	Formal	2	1	2	1	2
Handler	Sharples et al.	2002	Independent	4	5	1	1	2
HISS – Lernen im Krankenhaus	Cacace et al.	2004	Independent	1	1	1	1	1
Hypertag Magus Guide system	Naismith and Smith	2006	Physical	1	2	1	1	1
HyWeb	Jones et al.	2002	Independent	1	1	1	1	1
ImagiProbe	Vahey and Crawford	2002	Physical	4	1	1	1	1
IVR	Cooney and Keogh	2007	Independent	2	1	1	1	1
JAPELAS und Tango	Ogata and Yano	2004	Formal	2	1	2	1	3
Kanji Learning System	Lin and Mase	2006	Independent	2	1	1	1	1
Keyoe	Burke et al.	2005	Socializing	4	5	1	2	4
KLIV	Brandt and Hillgren	2004	Socializing	5	4	3	3	3
KnowMobile	Smørdal and Gregory	2003	Independent	1	1	2	2	1
Learning2go	Hawkins et al.	2007	Formal	2	2	2	1	2
LO	Bradley et al.	2007	Independent	2	1	1	1	1
LOCH	Paredes et al.	2005	Socializing	5	3	1	3	3
LOTM	Thornton and Houser	2004	Independent	2	1	1	1	1
MCSCL system	Cortez et al.	2004	Formal	2	1	3	1	2
M-Eco-Learn	Crom and Jager	2006	Physical	2	4	4	3	2
ME-Learning Experience	E. P. de Crom and Jager	2005	Physical	1	5	1	3	4
mExplorer	Göth et al.	2004	Physical	2	2	3	1	3

Name	Authors	Year	Context	Tools	Control	Communication	Subject	Objective
mid-2000	Virtanen et al.	2002	Independent	1	1	1	1	1
Milk	Polson and Morgan	2007	Physical	2	1	1	1	1
M-Learning	Fallahkhair et al.	2005	Independent	2	1	1	1	1
mLerning Support	So	2007	Formal	2	1	1	1	1
Mobile cinematic presentations	Zancanaro et al.	2003	Physical	2	2	1	2	2
Mobile Learning Passport	Lai et al.	2005	Physical	3	3	2	1	2
Mobile Lessons	Pintus et al.	2004	Physical	2	1	1	1	1
Mobile Notes	Bollen et al.	2006	Formal	2	1	2	1	2
Mobile Spreadsheet	Tan and Goh	2006	Formal	2	2	1	1	1
mobileAuthor	Virvou and Alepis	2005	Independent	2	1	1	1	1
MoCoCoMa	Silander et al.	2004	Formal	5	4	5	1	2
Moles	Melzer et al.	2006	Physical	5	4	5	1	3
Moop	Mattila and Fordell	2005	Physical	5	3	5	1	2
MoreMath	Bull and Reid	2003	Independent	2	1	1	1	2
Motus2	Divitini and Morken	2005	Physical	4	4	4	3	3
MoULe	Arrigo et al.	2007	Physical	5	4	5	1	1
M-Quiz	Meawad and Stubbs	2006	Independent	2	1	1	1	1
Multimedia m-learning	Benta et al.	2004	Independent	1	1	1	1	1
Museum OutsideWalls	Arvanitis	2005	Physical	4	5	1	1	2
Musex	Yatani et al.	2004	Physical	2	1	2	1	1
Musis	Milrad et al.	2005	Independent	1	1	1	1	1
MyArtSpace	Vavoula et al.	2007	Physical	2	2	2	1	2
NAIT	Roberts et al.	2003	Independent	1	1	1	1	1
Numina	Heath et al.	2005	Formal	2	2	2	1	1
PDA Learning Environment	McAlister and Xie	2005	Independent	2	1	1	1	1
Pebbles	Chen et al.	2000	Formal	2	1	2	1	2
periLearn	Winters	2007	Physical	5	5	2	1	1
PerkamII	El-Bishouty et al.	2006	Physical	2	1	1	1	1

Name	Authors	Year	Context	Tools	Control	Communication	Subject	Objective
Photostudy	Joseph et al.	2005	Socializing	5	4	5	3	1
PLASPS	Yin et al.	2006	Formal	3	2	1	1	3
Prodcasting	Clark et al.	2007	Independent	1	1	1	1	1
Qwizdom	Naismith et al.	2005	Formal	2	1	2	1	2
RAFT	Hine et al.	2004	Physical	2	1	3	1	2
Savannah	Facer et al.	2004	Formal	2	3	4	1	2
Skills Arena	Lee et al.	2004	Independent	2	1	1	1	1
SMS Messaging	Tretiakov and Kinshuk	2005	Formal	2	1	2	1	2
SMS reference and the cavalry	Noessel	2003	Independent	1	1	1	1	1
Speech PDA	Yang et al.	2005	Independent	2	1	1	1	1
Stanford Learning Lab	Trifonova	2003	Independent	2	1	1	1	1
StudentPartner	Hwang et al.	2007	Independent	1	1	1	1	1
Syllable-MCSCL	Zurita and Nussbaum	2004	Formal	3	2	5	1	1
TANGO	Ogata et al.	2006	Physical	2	5	2	1	1
Tate Modern Multimedia Tour Pilots	Proctor and Burton	2004	Physical	1	2	1	1	1
The LostWorlds of Somers Town	Bradley et al.	2005	Physical	1	1	2	1	1
UniWAP	Seppälä and Alamäki	2003	Socializing	5	3	5	3	4
Virtual Exhibitions	Kusunoki et al.	2002	Physical	1	1	1	1	1
Virus	Colella	2000	Formal	2	3	4	1	2
WiTEC	Liu et al.	2003	Formal	2	1	2	1	2
xTask	Ketamo	2003	Independent	5	4	5	1	3
Xyber-learning	Song and Fox	2005	Independent	2	1	1	1	1

Appendix 16a: Contextual mapping of educational technologies and learning theories progression*

Pre-1970	1970s	1980s	1990s	2000s	2010s
Telephone / Fax machine / Mobile radios 1st wireless phone Calculator, Dynabook	PCs / Portable PCs, OCR Scientific calculator	1st handheld device Electronic organisers Solar-powered calculator Apple II & Mac	Apple's Newton MessagePad, PDAs Windows & laptop PCs	Wireless PDAs & smartphones (including BB / Apple's iPod and iPhone	Tablets PCs, Apple iPad 4G standards / 3D technology
OS/360; Phone service Air-to-ground radio communications; TV; Satellites; RAM invented	Arpanet / Ethernet Cellular service proposal (US FCC)	TCP/IP; Wireless general / commercial use by US FCC Analog AMPS	1st browser/Wireless LAN (Wi-Fi) / WAP / WML / GSM (2G) / GPRS / SMS / Digital AMPS	Symbian / Palm / Pocket PC / WM / BB / iPhone / Android OS, Cloud, 3G networks, Bluetooth	Windows 8 4G standards finalised / 4G networks enabled
Stimulus-Response; Behaviourism; Maslow's Andragogy; Constructivism; ID / ISD	Knowles: informal / formal learning / Andragogy	LL / Kolb / CBT; Situated, constructivist	PBL / LL; Constructivist; Social constructivist; ADDIE* / ID* / ISD	Informal learning / Contextual learning; Social learning media	*Expectations for better blended learning; smarter mobility and more use of mobile learning "apps"*
s-learning (social) / t-learning or tv-learning (television)	v-learning (visual)	a-learning (ambience) / c-learning (collaborative) /	e-learning (electronic) / b-learning (blended)	c-learning (capacity) / m-learning (mobile) / p-learning (personalised) / p-learning (pervasive) / v-learning or vr-learning (virtual reality)	a-learning or ar-learning (augmented reality) /

** Keys for abbreviations used above in the image on the next page.*

Appendix 16b: Contextual mapping layout explanation and abbreviations keys

Pre-1970	1970s	1980s	1990s	2000s	2010s
ID: Instructional Design Marslow: Abraham Marslow's hierarchy of needs RAM: Random Access Memory TV: Television	OCR: Optical Character Recognition	CBT: Computer-based training Kolb: Kolb's learning styles Mac: Macintosh TCP/IP: Transmission Control Protocol/Internet Protocol	2G: 2nd Generation GSM/GPRS: Global System for Mobile Communications/General packet radio service LAN: Local Area Network PBL: Problem-based learning SMS: Short Message Service	3G: 3rd Generation BB: BlackBerry Cloud: Cloud computing WM: Windows Mobile	3D: 3-Dimension 4G: 4th Generation

KEYS FOR COLUMN / DECADE SPECIFIC ABBREVIATIONS

** **ADDIE ID** is the acronym for an **Instructional Design (ID)** model made up of five phases: (1) **Analysis**, (2) **Design**, (3) **Development**, (4) **Implementation** and (5) **Evaluation***

GENERIC KEYS FOR MAPPING LAYOUT AND GENERIC ABBREVIATIONS:

Row 1/arrow	*Decades*	LL	Lifelong Learning
Row 2	*Educational technologies / innovations*	m-learning / ML	mobile learning
Row 3	*Software / connectivity / communication*	OS	Operating Systems
Row 4	*Education / learning theories progression*	PC	Personal Computer
Row 5	*Learning terms progression*	PDA	Personal Digital Assistant
AMPS	Advanced Mobile Phone System	US FCC	United States Federal Communications Commission
HSCSD	High speed circuit switched data	WCDMA	Wideband Code Division Multiple Access
ISD	Instructional Systems Design		

Appendix 17: Mobile educational technology timeline

Appendix 18: Citation report data

Table 1: Journal citation report data for the journals in the top 5 publication sources

		JCR Data						Eigenfactor® Metrics	
Position in top 5	Source Title	2011 total cites	Impact factor	5-year impact factor	Immediacy index	2011 items	Cited half-life	Eigenfactor® score	Article Influence® score
1	Computers & Education	3557	2.621	2.97	0.498	229	3.5	0.00985	0.6
2	Educational Technology & Society	762	1.011	1.21	0.06	84	4.5	0.00232	0.295
4	Journal of Computer Assisted Learning	769	1.464	1.76	0	44	6.2	0.00196	0.525

Table 2: Articles included in the h-index calculation in citation count order

	Title	Authors	Source Title	Publication date	Keywords	Citations	Annual average	Self-citations
1	A ML system for scaffolding bird watching learning	Chen, YS; Kao, TC; Sheu, JP	JOURNAL OF COMPUTER ASSISTED LEARNING	SEP 2003	bird-watching; formative; Intranet; mobile; quantitative; scaffolding; school; wireless	89	8.09	5
2	The effectiveness of m-learning in the form of podcast revision lectures in higher education	Evans, Chris	COMPUTERS & EDUCATION	FEB 2008	adult learning; distance education and telelearning; evaluation of CAL systems; human-computer interface; teaching/learning strategies	75	12.50	0
3	Context aware ubiquitous learning environments for peer-to-peer collaborative learning	Yang, SJH	EDUCATIONAL TECHNOLOGY & SOCIETY	2006	ubiquitous learning; context aware; peer-to-peer; collaborative learning	67	8.38	7
4	The Design and Implementation of a Mobile Learning Resource	Sharples, Mike; Corlett, Dan; Westmancott, Oliver	PERSONAL AND UBIQUITOUS COMPUTING	MAY 2002	collaborative learning; handheld learning device; interactive learning environments; knowledge map; ML	67	5.58	0

	Title	Authors	Source Title	Publication date	Keywords	Citations	Annual average	Self-citations
5	Using mobile phones in English education in Japan	Thornton, P; Houser, C	JOURNAL OF COMPUTER ASSISTED LEARNING	JUN 2005	e-mail; foreign language learning; individual; mobile phones; multimedia; quantitative; undergraduate; video; World Wide Web	63	7.00	0
6	Mobile learning: A framework and evaluation	Motiwalla, Luvai F.	COMPUTERS & EDUCATION	NOV 2007	ML; mobile games; game based learning; conversational framework; educational assessment; self-assessment	62	8.86	0
7	Wireless and mobile technologies to enhance teaching and learning	Liu, TC; Wang, HY; Liang, JK; Chan, TW; Ko, HW; Yang, JC	JOURNAL OF COMPUTER ASSISTED LEARNING	SEP 2003	wireless; mobile; ubiquitous computing; project-based learning; interactive; primary; IT-use	54	4.91	7
8	Criteria, strategies and research issues of context-aware ubiquitous learning	Hwang, Gwo-Jen; Tsai, Chin-Chung; Yang, Stephen J. H.	EDUCATIONAL TECHNOLOGY & SOCIETY	2008	ubiquitous learning; context awareness; science education; wireless networks; ubiquitous computing	52	8.83	23
9	A constructivist ML environment supported by a wireless handheld network	Zurita, G; Nussbaum, M	JOURNAL OF COMPUTER ASSISTED LEARNING	AUG 2004	collaboration; constructivist; handhelds; mobile computer-supported collaborative learning; primary; qualitative; quantitative; school	50	5.00	14
10	Mobile learning with a mobile game: design and motivational effects	Schwabe, G; Goth, C	JOURNAL OF COMPUTER ASSISTED LEARNING	JUN 2005	computer supported cooperative learning; computer supported cooperative play; E-learning; mobile & wireless games; ML; positioning systems	37	4.11	1
11	A knowledge engineering approach to developing mindtools for context-aware ubiquitous learning	Chu, Hui-Chun; Hwang, Gwo-Jen; Tsai, Chin-Chung	COMPUTERS & EDUCATION	JAN 2010	interactive learning environments; mobile and ubiquitous learning; mindtools; knowledge engineering; repertory grid	35	9.00	19
12	iTunes University and the classroom: Can podcasts replace Professors?	McKinney, Dani; Dyck, Jennifer L.; Luber, Elise S.	COMPUTERS & EDUCATION	APR 2009	media in education; multimedia/hypermedia systems; post-secondary education; distance education and telelearning; pedagogical issues; student-achievement; lecture notes; notetaking	35	7.00	0

	Title	Authors	Source Title	Publication date	Keywords	Citations	Annual average	Self-citations
13	Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle	Chen, Chih-Ming; Chung, Ching-Ju	COMPUTERS & EDUCATION	SEP 2008	ML; personalized learning; English vocabulary learning; item response theory; learning memory cycle	35	5.83	1
14	Concept and design of Ad Hoc and Mobile classrooms	Chang, CY; Sheu, JP; Chan, TW	JOURNAL OF COMPUTER ASSISTED LEARNING	SEP 2003	ad hoc classroom; eSchoolbag; handheld; mobile classroom; school; student-centred; wireless	35	3.18	3
15	Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques	Chen, G. D.; Chang, C. K.; Wang, C. Y.	COMPUTERS & EDUCATION	JAN 2008	ubiquitous learning; student model; ML; learning portfolio; learning performance	34	5.67	0
16	A knowledge engineering approach to developing e-libraries for ML	Chu, Hui-Chun; Hwang, Gwo-Jen; Huang, Shu-Xian; Wu, Ting-Ting	ELECTRONIC LIBRARY	2008	libraries; digital storage; computer based learning; sciences; education	29	5.00	19
17	Investigating the determinants and age and gender differences in the acceptance of ML	Wang, Yi-Shun; Wu, Ming-Cheng; Wang, Hsiu-Yuan	BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY	JAN 2009	information technology usage; user acceptance; intrinsic motivation; perceived ease; longitudinal-field; older-adults; playfulness; model; behavior; adoption	28	5.60	0
18	Using short message service to encourage interactivity in the classroom	Markett, C; Sanchez, IA; Weber, S; Tangney, B	COMPUTERS & EDUCATION	APR 2006	nteractivity; sms; mobile phone; ubiquitous learning; wireless; devices	27	3.38	0
19	Mobile learning in teacher training	Seppala, P; Alamaki, H	JOURNAL OF COMPUTER ASSISTED LEARNING	SEP 2003	case study; change; distributed; handheld; interview; IT-use; mobile; teachers; training; wireless	27	2.45	0
20	A Heuristic Algorithm for planning personalized learning paths for context-aware ubiquitous learning	Hwang, Gwo-Jen; Kuo, Fan-Ray; Yin, Peng-Yeng; Chuang, Kuo-Hsien	COMPUTERS & EDUCATION	FEB 2010	interactive learning environments; ML; context-awareness; ubiquitous learning; heuristic algorithms	26	6.75	14

	Title	Authors	Source Title	Publication date	Keywords	Citations	Annual average	Self-citations
21	Evaluation of a ML organiser for university students	Corlett, D; Sharples, M; Bull, S; Chan, T	JOURNAL OF COMPUTER ASSISTED LEARNING	JUN 2005	hand-held computer; learning organiser; ML; undergraduate student	24	2.67	1

Table 3: Brief description of articles included in the h-index

Title	Authors	Publication date	Summary from abstract information
A constructivist ML environment supported by a wireless handheld network	Zurita, G; Nussbaum, M	AUG 2004	Presents the result of a trial comparing the use of wireless devices to facilitate constructivism and collaboration to an environment without technological support.
A Heuristic Algorithm for planning personalized learning paths for context-aware ubiquitous learning	Hwang, Gwo-Jen; Kuo, Fan-Ray; Yin, Peng-Yeng; Chuang, Kuo-Hsien	FEB 2010	Presents an implementation of a heuristic algorithm for a context-aware ubiquitous learning environment to detect and support students learning. Also presents experimental results from activities in a natural science butterfly-ecology course of an elementary school.
A knowledge engineering approach to developing e-libraries for ML	Chu, Hui-Chun; Hwang, Gwo-Jen; Huang, Shu-Xian; Wu, Ting-Ting	2008	To overcome identified problems when using MDTs for practical learning activities, the paper presents the results of an experimental study addressing the issues by using knowledge engineering to develop Mindtools for learning scenarios.
A knowledge engineering approach to developing mindtools for context-aware ubiquitous learning	Chu, Hui-Chun; Hwang, Gwo-Jen; Tsai, Chin-Chung	JAN 2010	Presents an experimental study involving the use of e-libraries with metadata to support students in a ML environment.
A ML system for scaffolding bird watching learning	Chen, YS; Kao, TC; Sheu, JP	SEP 2003	A ML system was presented for outdoor bird-watching activity using mobile devices. The system used Wi-Fi technologies and scaffolding to support students' learning.
Concept and design of Ad Hoc and Mobile classrooms	Chang, CY; Sheu, JP; Chan, TW	SEP 2003	Presents an implementation of ML in Ad Hoc and Mobile classrooms in a new learning environment using wireless technologies.

Title	Authors	Publication date	Summary from abstract information
Context aware ubiquitous learning environments for peer-to-peer collaborative learning	Yang, SJH	2006	Outlines the implementation of a context aware ubiquitous learning environment, suggesting how such environments can support peer-to-peer / collaborative learning.
Criteria, strategies and research issues of context-aware ubiquitous learning	Hwang, Gwo-Jen; Tsai, Chin-Chung; Yang, Stephen J. H.	2008	Presents suggestions of requirements for context-aware ubiquitous learning environment using mobile devices.
Evaluation of a ML organiser for university students	Corlett, D; Sharples, M; Bull, S; Chan, T	JUN 2005	A 10-month trial of a ML organiser for university students, implemented on a wireless-enabled Pocket PC hand-held computer.
Investigating the determinants and age and gender differences in the acceptance of ML	Wang, Yi-Shun; Wu, Ming-Cheng; Wang, Hsiu-Yuan	JAN 2009	Conducted a survey to investigate factors affecting students' intention to use mobile devices in learning. The results of the study suggesting performance expectancy, effort expectancy, social influence, perceived playfulness, and self-management of learning could be important determinants.
iTunes University and the classroom: Can podcasts replace Professors?	McKinney, Dani; Dyck, Jennifer L.; Luber, Elise S.	APR 2009	Presents an experimental study into the use of podcasts of audio lectures to support students learning. The study compared the results of a group using lectures and PowerPoint slides with another group using podcasts of the same lectures, finding there was learning gain in the latter group.
Mobile learning in teacher training	Seppala, P; Alamaki, H	SEP 2003	Use of mobile technology in teacher training. Supervisors and trainees discus and share ideas about teaching methods through using SMS and sharing digital images.
Mobile learning with a mobile game: design and motivational effects	Schwabe, G; Goth, C	JUN 2005	Presents an evaluation of a mobile game prototype (MobileGame) in a university setting including results of two trials.
Mobile learning: A framework and evaluation	Motiwalla, Luvai F.	NOV 2007	Presents a project which extends online content into wireless / handheld devices based on a ML framework. The result of a pilot study using the system was also presented.

Title	Authors	Publication date	Summary from abstract information
Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle	Chen, Chih-Ming; Chung, Ching-Ju	SEP 2008	Presents a personalised mobile English vocabulary learning system. The system is encourages students by recommending vocabularies based on their ability and learning memory cycle and using PDA devices.
The Design and Implementation of a Mobile Learning Resource	Sharples, Mike; Corlett, Dan; Westmancott, Oliver	MAY 2002	A working prototype of a handheld learning device used to support children aged 9-11 is discussed and evaluated. Children can use the system to capture everyday events such as images, notes and sounds, to relate them to web-based learning resources, to organise these into a visual knowledge map, and to share them with other learners and teachers.
The effectiveness of m-learning in the form of podcast revision lectures in higher education	Evans, Chris	FEB 2008	Presents the result of a study evaluating the effectiveness of using podcasts to encourage students to revise after lectures. Apple's iPod and digital media player are among the devices the students are assumed to have used.
Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques	Chen, G. D.; Chang, C. K.; Wang, C. Y.	JAN 2008	Presents an experimental study using mobile devices to access online resources in a ubiquitous ML environment.
Using mobile phones in English education in Japan	Thornton, P; Houser, C	JUN 2005	Arising from a poll study of university students' use of mobile devices, an experimental trial using mobile devices to encourage students to study further was presented with results. Students receive messages each week prompting them to further studies.
Using short message service to encourage interactivity in the classroom	Markett, C; Sanchez, IA; Weber, S; Tangney, B	APR 2006	Presents the PLS TXT UR Thoughts research project which allows students to send SMS during sessions, receiving verbal responses which may develop into interactive activities with the students.
Wireless and mobile technologies to enhance teaching and learning	Liu, TC; Wang, HY; Liang, JK; Chan, TW; Ko, HW; Yang, JC	SEP 2003	Describes the integration of wireless technologies and mobile devices with other educational technologies such as electronic whiteboard. Also presents some suggestions for further explorations.

Appendix 19: Survey results (preliminary data analysis)

Demographical information

		Learning support / governance	Academics	Students
Age	**Under 21**			35.90%
	21-30			10.26%
	31-40			15.38%
	41-50			5.13%
	50+			5.13%
	No answer			28.21%
Gender	**Male**	27.27%		35.90%
	Female	45.45%		35.90%
Educational sector Keys: CE: Compulsory education FE: Further education & colleges HE: Higher education (& universities)	**CE**	0%	0%	0%
	FE	4.76%	0%	2.56%
	HE	59.52%	73.73%	66.67%
	Other	0%	0%	2.56%
	No answer	35.71%	27.27%	28.21%
Length of teaching experience (in years)	**< 10%**			
	10-25%			
	26-50%	9.09%		
	51-75%	9.09%		
	Over 75%	54.55%		
	No answer	27.27%		
Percentage of week spent supporting / governing learning & teaching / studying	**< 10%**		14.29%	
	10-25%		19.05%	2.56%
	26-50%		19.05%	66.67%
	51-75%		9.52%	2.56%

	Over 75%			
	No answer		38.10%	28.21%
Type of learners **Keys:** **Face: Learners attending face to face sessions** **Distance: Distance learners** **Online: Online learners/** **CORR: Correspondence learners**	**Face**		59.52%	64.10%
	Distance		11.90%	7.69%
	Online		21.43%	10.26%
	CORR		2.38%	0%
	No answer		4.76%	17.95%
Main subject / discipline(s) area **Keys:** **ABP: Architecture, Building & Planning** **BAS: Business & Administrative Studies** **CAD: Creative Arts & Design** **EDU: Education** **ENT: Engineering & Technologies** **GAT: Games Technology** **HMS: Health (Medicine, Dentistry & Medicinal) Sciences** **JMS: Journalism, Media Studies & Communication** **LAN: Languages** **LAW: Law** **LMS: Library & Museum Studies** **MCS: Mathematics, IT & Computer Science** **PRS: Physical, Recreational & Sports Sciences** **PHY: Physiology** **PPS: Psychology, Political & Social Sciences** **SCI: Sciences** **TTT: Transportation, Travel & Tourism**	**ABP**		0%	3.57%
	BAS		9.52%	0%
	CAD		2.38%	0%
	EDU		7.14%	3.57%
	ENT		14.29%	17.86%
	HMS		2.38%	7.14%
	JMS		4.76%	0%
	LAW		0%	3.57%
	LMS		2.38%	0%
	MCS		4.76%	32.14%
	PRS		0%	3.57%
	PPS		0%	17.86%
	TTT		2.38%	0%
	Other • **LAN** • **SCI** • **GAT** • **LAN** • **PHY**		7.14%	10.71%
	No answer		42.86%	28.21%
Country **Keys:**	UK	45.45%	47.62%	85.71%
	CAN			3.57%

UK: United Kingdom **CAN: Canada** **FRA: France** **IRE: Ireland** **JOR: Jordan** **NIG: Nigeria** **NEZ:** New Zealand **PAK: Pakistan** **TUR: Turkey** **UGA: Uganda** **USA: United States**	FRA			3.57%
	IRE			3.57%
	JOR		2.38%	
	NIG		2.38%	
	NEZ	9.09%		
	PAK			3.57%
	TUR		2.38%	
	UGA		2.38%	
	USA	18.18%		
	No answer	27.27%	42.86%	28.21%
No of respondents		11	42	39

Part A (Questions & Responses): Use of mobile devices in learning and teaching (Academics and students only):

Q1a: Are you currently using mobile device(s) in your teaching / learning?		
	Academics	**Students**
Yes (Yes)	26.19%	66.67%
No (No)	35.71%	28.21%
No answer	38.10%	5.13%
Q1b: [IF NO] Have you ever used mobile device(s) within your teaching / learning?		
	Academics	**Students**
Yes (Yes)	9.52%	12.82%
No (No)	23.81%	15.38%
Q1c: [IF NO] Please tell us why you stopped using (or have never used) devices?		
	Academics	**Students**
Limited or lack of funding.	4.76%	2.56%
There was never an opportunity.	11.90%	0%
Mobile learning is not actively supported by / promoted in my institution.	4.76%	5.13%
No exemplar / good practice guidelines.	4.76%	5.13%
Costs too much to develop materials.	2.38%	0%
Takes too long or too much effort to develop materials.	7.14%	0%
It causes disruption and makes classroom management difficult.	0%	0%
It does not add notable value to student learning.	2.38%	2.56%
It does not add notable value to learning processes.	4.76%	0%
I don't believe it can help transform education.	2.38%	0%
Other	9.52%	0%
	• I do use laptops and podcasts - but training • Traditional methods still exists • The technology I used is no longer availabl again	

Part B (Questions & Responses): Description / evaluation of current uses in learning and teaching (Academics and students / all sub-groups)

Q2a: Please indicate how you are using / have used mobile devices in your teaching / learning		Phones	PDA	Gaming	MP3	iPad	Tablets	eBooks
To access web-based learning materials and online services.								
	Academics	20.00%	13.33%	0%	20.00%	20.00%	40.00%	6.67%
	Students	35.48%	35.48%	6.45%	12.90%	19.35%	74.19%	6.45%
SMS messaging to interact with tutor about learning.								
	Academics	13.33%	0%	0%	6.67%	0%	13.33%	0%
	Students	19.35%	6.45%	0%	0%	3.23%	12.90%	0%
SMS messaging to interact with other students / peers.								
	Academics	13.33%	6.67%	0%	6.67%	0%	13.33%	0%
	Students	54.84%	25.81%	3.23%	0%	12.90%	25.81%	0%
To record information about learning for use later.								
	Academics	33.33%	13.33%	0%	26.67%	0%	13.33%	0%
	Students	29.03%	32.26%	0%	16.13%	16.13%	51.61%	3.23%
To participate in group learning activities.								
	Academics	20.00%	6.67%	6.67%	13.33%	6.67%	13.33%	0%
	Students	22.58%	12.90%	0%	6.45%	12.90%	51.61%	3.23%

Keys:

Phones	Mobile phones (except PDAs and smart phones)
PDA	Personal Digital Assistant (PDA) / smart phones
Gaming	Nintendo / other gaming device
MP3	iPods / MP3 / digital recorders etc
iPad	iPad or similar
Tablets	Notebooks / Tablet PC / laptops
eBooks	eBook readers (e.g. Kindle)

	Academics	Students
Q2b: Other uses	• Database use: many now have apps for students to use. • Use phone cameras to record evidence and audio recording for same	• Create documents and powerpoints

Q3: Why did / do you use mobile devices in your teaching / learning?		
	Academics	**Students**
	% of total	**% of total**
The institution provided devices to students.	0.00%	5.13%
Students used their own devices.	17.78%	61.54%
I obtained internal funding to use devices.	4.44%	
I obtained external funding for a ML project.	2.22%	
The institution (commonly) supported and encouraged the use mobile devices in learning.	13.33%	15.38%
There were awareness sessions and institution-led culture change for ML.	0.00%	7.69%
I was inspired by champion, early adopters and sharing good practice schemes.	6.67%	
Institution provided IT resources and support for mobile content development.	0.00%	
It supports / enhances students' learning overall.	8.89%	41.03%
It motivates students to study on their own.	4.44%	46.15%
It supports / encourages collaborative learning.	6.67%	23.08%
It supports / encourages self-directed learning.	8.89%	28.21%
It provides quick / convenient access to information.	4.44%	51.28%
Tutors / colleagues recommended using devices.	6.67%	17.95%
Using devices makes it easier to achieve learning objectives.	8.89%	23.08%
Using devices could increase gains in learning.	4.44%	
Other	2.22%	2.56%
	• It enabled a simulation, which pointed the way to the possibility of an effective version	• For aging students like me I think they are fantastic. They provide ready access help in learning

Q4: When is mobile device usage in learning most effective?			
	Learning support / governance	**Academics**	**Students**
in all learning contexts	9.09%	7.14%	25.64%
in some learning contexts only	72.73%	47.62%	48.72%

in certain subjects only	54.55%	30.95%	30.77%
in all subjects	27.27%	23.81%	43.59%
only when devices can be provided for students	0%	14.29%	5.13%
only when students can provide own devices	0%	4.76%	2.56%
in either case, provided it is sustainable	72.73%	30.95%	64.10%
only with learners that have no easy access to education	0%	2.38%	0%
only with learners that are experts in the use of technology	0%	2.38%	10.26%
with all types of learners regardless of profile or demographic, when used appropriately	72.73%	47.62%	61.54%
in informal learning	9.09%	0%	0%
in collaborative learning	9.09%	9.52%	2.56%
in varying types of learning modes (blended)	54.55%	38.10%	71.79%
in traditional (face-to-face) sessions	0%	0%	0%
in distance / correspondence learning	0%	7.14%	0%

Part C (Questions & Responses): Drivers and barriers (All sub-groups)

Q5a: Are you or anyone you know using mobile devices in learning context(s)?
[ACADEMICS] Are your students using mobile devices in their learning?

	Learning support / governance	Academics	Students
	% of total	% of total	% of total
Yes (Yes)	45.45%	33.33%	46.15%
No (No)	27.27%	14.29%	7.69%
Don't know (DKB)	9.09%	23.81%	28.21%
No answer	18.18%	28.57%	17.95%

Q5b: Uses of mobile devices by colleagues and friends	• Promoting use of mobile friendly versions of eResources and making use of QR codes to link to online help • The ALPS project - occupational therapy videos delivered in the field via mobile devices. • In informal learning setting mobile devices are used extensively. I have published a paper on craft brewers using devices in proceedings of networked • As a catalyst for student-generated content and student-generated learning contexts	• They got the ML materials and able to read them then check with surveys • Note taking, viewing videos, accessing VLE, translation dictionaries, using social media • iPad used to make notes during lectures • Commenting with each other; podcasts and iTunes • Recording homework in calendar, recording evidence • During class to pull up info, accessing material (e.g. podcasts we provide) • To reflection on their practice • To take and share photos/video and (in the past) to participate in simulation of practice dilemmas • Control a robot in AI • Sharing joint documents in group work and group discussion	• They use them for listening to podcasts and to record their own voice. • Study groups accessing library info. web searching • Same way as I do and we link up for topic discussions and knowledge exchange. • To create study groups, to SMS questions to tutors • MP3 - online videos to learn human anatomy • Same as me • Recorder, notebooks, laptops, mobile phones, smart phone, eBook readers, blackberry, iPads. Used to record lecture, gaming, social network & internet browsing • They use them in the same manner that I do, accessing online work, easy access to coursework. • In the same way as I am, on the same module • Mostly for access to online materials, and to communicate with others on my course. • iPads and laptops for reading revision notes, lecture notes. • Feedback via Moodle. Revision on PDF/Word documents. • Recording notes in lectures, accessing online material. • In much the same way as I do; mainly as a source of accessing online resources, finding and storing information, and contacting tutors/colleagues. • They use mobile devices to access learning materials and overall during the course they are studying. They are used to take notes during lectures. • Using internet to look up articles.

Q6: Rate each of the following (0 for *least serious* and 4 for *most serious*)										
	%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
Expense of suitable devices.										
	Learning support / governance	77.78%	17	0.73	2.43	1	2.00	2.00	3.00	3
	Academics	50.00%	39	0.78	3.00	2	2.00	3.00	4.00	4
	Students	92.86%	79	0.94	3.04	1	2.00	3.00	4.00	4
Lack of WiFi or Bluetooth connectivity.										
	Learning support / governance	88.89%	23	0.93	2.88	2	2.00	2.50	4.00	4
	Academics	53.85%	38	0.96	2.71	1	2.00	2.50	4.00	4
	Students	89.29%	76	1.34	3.04	0	2.50	4.00	4.00	4
Learning materials not available for devices.										
	Learning support / governance	77.78%	16	1.28	2.29	0	1.00	2.00	3.00	4
	Academics	50.00%	35	1.20	2.69	1	1.50	2.00	4.00	4
	Students	82.14%	71	0.88	3.09	1	2.00	3.00	4.00	4
Lack of supporting technologies / software.										
	Learning support / governance	100.00%	20	1.13	2.22	1.00	1.00	2.00	3.50	4
	Academics	61.54%	42	0.99	2.63	1.00	2.00	2.50	3.75	4
	Students	89.29%	71	1.16	2.84	0	2.00	3.00	4.00	4
Teaching not designed for ML.										
	Learning support / governance	88.89%	19	1.22	2.38	0	2.00	2.00	3.75	4
	Academics	61.54%	44	1.25	2.75	1.00	1.00	3.00	4.00	4
	Students									
Limited accessibility & ongoing running cost.										
	Learning support / governance	66.67%	13	0.69	2.17	1	1.75	2.00	3.00	3
	Academics	42.31%	30	1.05	2.73	1	2.00	3.00	4.00	4
	Students	92.86%	70	0.99	2.69	1	2.00	3.00	3.25	4
Inadequate IT support in institution for use in learning.										
	Learning support / governance	100.00%	19	1.20	2.11	1	1.00	1.00	3.50	4
	Academics	61.54%	40	1.06	2.50	1	1.25	3.00	3.00	4
	Students	67.86%	54	1.23	2.84	0	2.00	3.00	4.00	4
Information takes too long to download to device.										
	Learning support / governance	66.67%	12	0.58	2.00	1	1.75	2.00	2.25	3

Q6: Rate each of the following (0 for *least serious* and 4 for *most serious*)										
		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
	Academics	46.15%	27	1.23	2.25	0	1.00	2.50	3.00	4
	Students	71.43%	54	1.23	2.70	0	2.00	2.50	4.00	4
Intrusion / disruption to students' personal time / space.										
	Learning support / governance	33.33%	6	0	2.00	2	2.00	2.00	2.00	2
	Academics	42.31%	28	0.99	2.55	1	2.00	2.00	3.00	4
	Students	60.71%	42	1.19	2.47	1	1.00	2.00	4.00	4
Modifying existing learning materials for devices.										
	Learning support / governance	66.67%	12	1.29	2.00	0	1.25	2.00	3.25	4
	Academics	61.54%	38	1.17	2.38	0	2.00	2.00	3.75	4
	Students	78.57%	55	1.16	2.50	0	2.00	3.00	3	4
Potential exposure to virus attack.										
	Learning support / governance	22.22%	6	0	3.00	3	3.00	3.00	5.25	3
	Academics	34.62%	17	0.99	1.89	1	1.00	1.00	2.50	4
	Students	60.71%	42	1.33	2.47	0	1.00	3.00	4.00	4
Bandwidth too low for non-stop / fast streaming.										
	Learning support / governance	77.78%	13	0.64	1.86	1	1.00	2.00	2.00	3
	Academics	46.15%	22	1.07	1.83	0	1.00	2.00	2.75	4
	Students	67.86%	53	1.20	2.79	1	2.00	3.00	4.00	4
Limited file types / formats supported by devices.										
	Learning support / governance	77.78%	11	0.49	1.57	1	1.00	1.00	2.00	2
	Academics	42.31%	22	0.95	2.00	0	2.00	2.00	2.00	4
	Students	71.43%	53	1.06	2.65	1	2.00	3.00	3.75	4
Devices used inappropriately in learning sessions (e.g. cyber bullying etc.).										
	Learning support / governance	44.44%	4	0.71	1	0	1.75	1.00	1.75	2
	Academics	38.46%	22	1.40	2.20	0	1.00	2.00	4.00	4
	Students	46.43%	34	1.33	2.62	0	1.50	2.00	4.00	4
Students' inability to use devices effectively.										
	Learning support / governance	66.67%	11	0.69	1.83	1	1.00	2.00	2.25	3
	Academics	38.46%	19	0.83	1.90	1	1.00	2.00	3.00	3
	Students	64.29%	45	1.17	2.50	0	1.75	3.00	3.25	4

Q6: Rate each of the following (0 for *least serious* and 4 for *most serious*)										
		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
Security and copyright issues.										
	Learning support / governance	33.33%	7	1.25	2.33	1	1.00	1.00	4.00	4
	Academics	42.31%	21	0.79	1.91	1	1.00	2.00	3.00	3
	Students	60.71%	40	1.37	2.35	0	1.00	2.00	4.00	4
Inadequate learning support out of sessions.										
	Learning support / governance	66.67%	15	0.96	2.50	1	1.75	2.5	3.25	4
	Academics	57.69%	28	0.81	1.87	1	1.00	2.00	3.00	3
	Students	60.71%	40	1.13	2.35	0	1.00	3.00	3.00	4
Device battery life.										
	Learning support / governance	77.78%	16	0.88	2.29	1	2.00	2.00	3.00	4
	Academics	46.15%	18	0.87	1.50	0	1.00	1.00	2.00	3
	Students	96.43%	62	0.94	2.30	1	2.00	2.00	3.00	4
Multiple screen sizes / networks / operating systems.										
	Learning support / governance	77.78%	11	0.49	1.57	1	1.00	1.00	2.00	2
	Academics	38.46%	25	1.02	2.50	1	1.75	2.50	3.25	4
	Students	78.57%	45	1.15	2.05	0	1.00	2.00	3.00	4
Lack of tracking / results for proper use.										
	Learning support / governance	55.56%	11	0.75	2.20	1	1.50	2.00	3.00	3
	Academics	46.15%	23	0.64	1.92	1	1.25	2.00	2.00	3
	Students									
Ethical issues relating to data protection.										
	Learning support / governance	44.44%	8	1.22	2.00	1	1.00	1.50	3.50	4
	Academics	46.15%	28	0.94	2.33	1	2.00	2.00	3.00	4
	Students	60.71%	30	1.31	1.76	0	1.00	1.00	3.00	4
Ethical issues relating to privacy.										
	Learning support / governance	44.44%	7	0.83	1.75	1	1.00	1.50	2.75	3
	Academics	50.00%	30	0.82	2.31	1	2.00	2.00	3.00	4
	Students	71.43%	37	1.24	1.85	0	1.00	1.50	3.00	4
Learning disruption & classroom management issues.										
	Learning support / governance	55.56%	9	0.98	1.80	0	3.00	2.00	2.50	3

Q6: Rate each of the following (0 for *least serious* and 4 for *most serious*)		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
	Academics	46.15%	19	1.11	1.58	0	1.00	1.50	2.00	4
	Students	53.57%	34	1.24	2.27	1	1.00	2.00	4	4
Keyboard (input device) difficult to use.										
	Learning support / governance	77.78%	17	1.05	2.43	1	1.00	2.00	3.00	4
	Academics	50.00%	25	0.73	1.92	1	1.00	2.00	2.50	3
	Students	78.57%	37	1.06	1.68	0	1.00	1.00	2.25	4
Potential health risks.										
	Learning support / governance	22.22%	3	0.50	1.50	1	1.75	1.50	3.50	2
	Academics	30.77%	11	0.86	1.38	0	1.00	1.00	2.00	3
	Students	32.14%	19	1.59	2.11	0	1.50	1.00	4.00	4
Changes in design models / functionalities.										
	Learning support / governance	66.67%	10	0.47	1.67	1	1.00	2.00	2.00	2
	Academics	38.46%	19	1.04	1.90	1	1.00	1.50	3.00	4
	Students	64.29%	28	0.96	1.56	0	1.00	1.00	2.00	4

Q7: Rate each of the following (0 for *least beneficial* and 5 for *most beneficial*)		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
Quick access to learning content / materials for students.										
	Learning support / governance	88.89%	29	0.99	3.63	2	2.50	4.00	4.00	5
	Academics	84.62%	69	3.35	3.14	1	1.50	2.00	5.00	5
	Students	96.43%	119	0.83	4.41	2	4.00	5.00	5.00	5
Provide access to information in remote locations.										
	Learning support / governance	88.89%	27	1.32	3.38	1	2.25	3.5	4.75	5
	Academics	84.62%	71	2.79	3.23	1	2.25	2.00	4.50	5
	Students	82.14%	96	0.96	4.17	2	4.00	4.00	5.00	5
Timely communication with students / peers.										
	Learning support / governance	77.78%	29	0.64	4.14	3	4.00	4.00	5.00	5
	Academics	80.77%	65	2.30	3.10	1	2.38	2.00	4.13	5
	Students	92.86%	103	1.32	3.96	1	3.00	5.00	5.00	5
Can positively enhance / support learning processes.										

Q7: Rate each of the following (0 for *least beneficial* and 5 for *most beneficial*)										
		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
	Learning support / governance	77.78%	26	0.88	3.71	2	3.00	4.00	4.00	5
	Academics	84.62%	71	2.81	3.23	1	1.88	2.00	4.88	5
	Students	92.86%	102	1.00	3.92	1	3.00	4.00	5.00	5
Quick access to social networking sites / email etc., for students.										
	Learning support / governance	88.89%	25	1.69	3.13	1	1.25	3.00	5	5
	Academics	73.08%	65	2.92	3.42	1	2.13	2.00	4.75	5
	Students	82.14%	87	1.41	3.78	1	3.00	4.00	5	5
Enables effective use of 'dead' / idle time.										
	Learning support / governance	66.67%	24	1	4.00	2	3.50	4.00	5	5
	Academics	76.92%	52	2.60	2.60	1	1.25	2.00	3.75	5
	Students	85.71%	98	1.11	4.08	2	3.25	4.50	5	5
Portability / 'wear' ability of mobile devices.										
	Learning support / governance	77.78%	29	0.64	4.14	3	4.00	4.00	5.00	5
	Academics	76.92%	59	2.49	2.95	1	1.50	2.00	3.75	5
	Students	75.00%	78	0.93	3.71	2	3.00	4.00	4.50	5
Introducing new technology to learners / learning.										
	Learning support / governance	66.67%	22	0.47	3.67	3	3.00	4.00	4.00	4
	Academics	80.77%	68	2.48	3.24	1	2.38	2.00	4.50	5
	Students	89.29%	88	1.27	3.52	1	3.00	3.00	5.00	5
Enables location-based / contextual learning.										
	Learning support / governance	88.89%	28	1.32	3.50	1	2.25	4.00	4.75	5
	Academics	80.77%	65	2.40	3.10	1	1.50	2.00	4.00	5
	Students	92.86%	88	1.30	3.38	1	2.00	3.00	5.00	5
Can support students with special needs.										
	Learning support / governance	77.78%	22	1.36	3.14	0	3.00	3.00	4.00	4
	Academics	80.77%	62	2.75	2.95	1	1.00	2.00	4.13	5
	Students	92.86%	89	1.45	3.42	0	2.75	3.00	5.00	5
Can motivate hard to reach students.										
	Learning support / governance	66.67%	24	0.58	4.00	3	3.75	4.00	4.25	5
	Academics	88.46%	61	2.56	2.65	1	1.38	2.00	3.88	5

Q7: Rate each of the following (0 for *least beneficial* and 5 for *most beneficial*)										
		%age	Sum	SD	Average	Min	Q1	Median	Q3	Max
	Students	89.29%	88	1.27	3.52	1	3.00	3.00	5.00	5
Just in time or provision of further learning support.										
	Learning support / governance	77.78%	23	1.03	3.29	2	2.00	3.00	4.00	5
	Academics	73.08%	46	1.88	2.42	1	1.88	2.00	3.13	4
	Students	82.14%	69	1.44	3.00	0	2.00	3.00	4.00	5
Competing with other institutions / colleagues.										
	Learning support / governance	44.44%	10	1.50	2.50	0	5.25	3.00	3.75	4
	Academics	69.23%	45	3.10	2.50	1	1.00	2.00	4.13	5
	Students	60.71%	46	1.27	2.71	1	1.00	3.00	4.00	5

Keys:

SD	Standard deviation
Q1	1st quartile (Q1)
Median	2nd quartile (Median)
Q3	3rd quartile (Q3)
Min	Minimum
Max	Maximum

Part D (Questions & Responses): Evaluation of value added (All sub-groups)

Q8: Providing revision materials and feedback support via mobile devices (e.g. by SMS texting or mobile applications) ….				
% for…		***Unsure***	***% for…***	
increases students' success rate in assessments			***makes no difference*** to students' success rate in assessments	
Learning support / governance	33.33%	22.22%	33.33%	**Learning support / governance**
Academics	19.05%	23.81%	14.29%	**Academics**
Students	30.77%	25.64%	15.38%	**Students**
annoys students and ***intrudes*** on students' privacy			***has little / no effect*** on students' privacy	
Learning support / governance	11.11%	22.22%	55.56%	**Learning support / governance**

Q8: Providing revision materials and feedback support via mobile devices (e.g. by SMS texting or mobile applications) ….				
Academics	9.52%	33.33%	14.29%	**Academics**
Students	7.69%	12.82%	51.28%	**Students**
is ***useful and helpful*** to students overall in learning			is ***not*** useful or helpful to students overall in learning	
Learning support / governance	44.44%	22.22%	22.22%	**Learning support / governance**
Academics	35.71%	19.05%	0%	**Academics**
Students	41.03%	20.51%	10.26%	**Students**
encourages students to seek further support when needed			***makes no difference*** to seeking further support	
Learning support / governance	55.56%	22.22%	11.11%	**Learning support / governance**
Academics	23.81%	28.57%	4.76%	**Academics**
Students	46.15%	10.25%	15.38%	**Students**
increases students' expenses and costs			***makes no difference*** to students' finances	
Learning support / governance	44.44%	22.22%	22.22%	**Learning support / governance**
Academics	14.29%	26.19%	16.67%	**Academics**
Students	15.38%	25.64%	30.77%	**Students**
is ***not preferred*** to class tutorials / revision classes			is **preferred** to class tutorials / revision classes	
Learning support / governance	33.33%	44.44%	11.11%	**Learning support / governance**
Academics	23.81%	30.95%	2.38%	**Academics**
Students	30.77%	28.21%	12.82%	**Students**
is **needed** in addition to tutorials / revision classes			is ***not needed*** in addition to tutorials / revision classes	
Learning support / governance	44.44%	33.33%	11.11%	**Learning support / governance**
Academics	26.19%	28.57%	2.38%	**Academics**
Students	46.15%	17.95%	7.69%	**Students**

Q9: Providing course / lecture materials for mobile devices ….		
% for…	***Unsure***	***% for…***
increases understanding of topic		***makes no difference*** to understanding of topic

Q9: Providing course / lecture materials for mobile devices ….				
Learning support / governance	55.56%	0%	33.33%	Learning support / governance
Academics	23.81%	14.29%	16.67%	Academics
Students	43.59%	20.51%	7.69%	Students
forces learners' to buy / finance expensive devices			***makes no difference*** to learners' reasons for buying devices	
Learning support / governance	22.22%	22.22%	44.44%	Learning support / governance
Academics	11.90%	30.95%	11.90%	Academics
Students	15.38%	20.51%	35.90%	Students
makes no difference to people with no suitable devices			is ***unfair*** to people with no suitable d	
Learning support / governance	33.33%	11.11%	44.44%	Learning support / governance
Academics	11.90%	19.05%	23.81%	Academics
Students	20.51%	15.38%	35.90%	Students
encourages learners to study anywhere at any time (make better use of free time)			***makes no difference*** to learners' private study patterns	
Learning support / governance	66.67%	11.11%	11.11%	Learning support / governance
Academics	40.48%	14.29%	0%	Academics
Students	53.85%	12.82%	5.13%	Students
is ***needed in addition*** to VLE or LMS and other content management system			is ***not needed in addition*** to VLE or LMS etc	
Learning support / governance	66.67%	0%	22.22%	Learning support / governance
Academics	35.71%	11.90%	7.14%	Academics
Students	28.21%	38.46%	5.13%	Students
is ***not preferred*** to VLE or LMS content			is ***preferred*** to VLE or LMS content	
Learning support / governance	33.33%	55.56%	0%	Learning support / governance
Academics	19.05%	33.33%	2.38%	Academics
Students	12.82%	48.72%	10.26%	Students

Q10: Using mobile devices in learning activities ….		
% for…	***Unsure***	***% for…***

Q10: Using mobile devices in learning activities ….				
makes learning interesting and motivating			***has no effect*** on learning processes	
Learning support / governance	55.56%	22.22%	11.11%	**Learning support / governance**
Academics	33.33%	19.05%	4.76%	**Academics**
Students	43.59%	12.82%	15.38%	**Students**
makes learning process more effective			***makes no difference*** to the effectiveness of learning processes	
Learning support / governance	44.44%	33.33%	11.11%	**Learning support / governance**
Academics	19.05%	28.57%	9.52%	**Academics**
Students	51.28%	10.26%	10.26%	**Students**
can ***positively transform*** learning processes			can ***negatively transform*** learning processes	
Learning support / governance	66.67%	22.22%	0%	**Learning support / governance**
Academics	40.48%	6.67%	0%	**Academics**
Students	48.72%	15.38%	7.69%	**Students**
cannot disrupt learning processes			***can be disruptive*** to learning processes	
Learning support / governance	11.11%	33.33%	44.44%	**Learning support / governance**
Academics	11.90%	23.81%	19.05%	**Academics**
Students	20.51%	30.77%	20.51%	**Students**
makes classroom management ***more difficult***			makes classroom management ***easier***	
Learning support / governance	0%	66.67%	22.22%	**Learning support / governance**
Academics	19.05%	30.95%	7.14%	**Academics**
Students	10.26%	43.59%	17.95%	**Students**
gives control to learners in learning processes			***makes no difference*** to learner control	
Learning support / governance	66.67%	22.22%	0%	**Learning support / governance**
Academics	40.48%	9.52%	7.14%	**Academics**
Students	41.03%	20.51%	10.26%	**Students**
gives more control to tutors in learning processes			**makes no difference** to tutor control	
Learning support / governance	11.11%	55.56%	22.22%	**Learning support / governance**
Academics	19.05%	16.67%	21.43%	**Academics**
Students	17.95%	38.46%	12.82%	**Students**

Q10: Using mobile devices in learning activities ….					
can be too much in addition to all other technologies used in learning				***cannot be excluded*** from the technologies used in learning	
Learning support / governance	0%	22.22%	66.67%	Learning support / governance	
Academics	14.29%	28.57%	14.29%	**Academics**	
Students	17.95%	35.90%	17.95%	**Students**	

Part E (Questions & Responses): Content and learning delivery (All sub-groups)

Q11: In your opinion, which of the following should be made available to support mobile content?		
	Learning support / governance	**Academics**
IT resources and support for content development (e.g. provision of relevant content development software and mobile device emulators on PCs).	63.64%	50.00%
Staff development training on content delivery and ML.	72.73%	52.38%
Mobile learning project collaborations across institutions.	45.45%	30.95%
Champions and early adopters sharing good practice.	63.64%	38.10%
Awareness sessions and institution-led culture change.	63.64%	40.48%
Funding support for ML projects.	54.55%	42.86%
Other	18.18%	0%
Comments for “Other”:	• Research with practical experience • Good quality research of ML being done without institutions trying to control device or 'encourage' our students to 'be more effective' maybe if we looked at what they do we could learn from them?	

Q12: Which of these technologies do you currently use in your teaching / learning?		
	Academics	**Students**
PowerPoint & downloadable material	57.14%	66.67%
Interactive web activities / online application	45.24%	56.41%
Blogs, wikis and similar	42.86%	30.77%
Podcasts, videocasts and similar	21.43%	28.21%
Twitter	19.05%	17.95%

Social networking sites	30.95%	41.03%
Multimedia & other similar resources	28.57%	30.77%
2D / 3D Virtual Worlds & simulations	9.52%	12.82%
Other	2.38%	2.56%
Comments for “Other”:	• mobile phone text	• email

Q13a: Do you make your teaching materials available for mobile devices?	
	Academics
Yes (Yes)	14.29%
No (No)	52.38%
No answer	33.33%

Q13b: [ACADEMICS – IF NO] Please tell us why you don’t	
	Academics
There was never an opportunity to do so.	23.81%
Costs too much to develop materials for mobile devices.	2.38%
Takes too much time / effort to develop materials for mobile devices.	14.29%
Platforms, networks, device screen size / functionalities etc too varied and always changing.	14.29%
No technical support provided by institution for content development.	11.90%
My students do not require mobile content in addition to what they have.	4.76%
Other	11.90%
Comments for “Other”:	• Need to be considered • Students should be able to use smart phones to connect to the learning environment through the web and find everything there, then we need only develop things once • Have not had an opportunity • Did not think about it • No specific reason

Q14: Do you think students would prefer that course materials are made available for mobile devices? [STUDENTS] Would you prefer that tutors make course materials available for mobile devices?

		Learning support / governance	Academics	Students
	Yes (Yes)	66.67%	30.95%	64.10%
	No (No)	11.11%	7.14%	7.69%
	Don't know (DKB)	11.11%	19.05%	
	No answer	11.11%	42.86%	28.21%

Q15: Which of these devices should course materials be made available for?

		Learning support / governance	Academics	Students
	Mobile phones (except PDAs and smart phones)	18.18%	14.29%	41.03%
	Personal Digital Assistant (PDA) / smart phones	45.45%	2.38%	35.90%
	Nintendo / other gaming device	18.18%	21.43%	0%
	iPods / MP3 / digital recorders etc	27.27%	23.81%	15.38%
	iPad or similar	54.55%	26.19%	30.77%
	Notebooks / Tablet PC / laptops	45.45%	14.29%	48.72%
	eBook readers (e.g. Kindle)	54.55%	0%	17.95%
	Other	18.18%	0%	0%
Comments for "Other":		• Cloud accessible • Standards-compliant devices irrespective of mobility or learning technologists faddish desire to promote them		

Comments / concerns (All sub-groups)

Q16: If you have other concerns about the use of mobile devices in learning and teaching, please explain briefly.

Learning support / governance	• I think it's not really a question of 'if', it's a question of resource and support. Of course our materials and resources should be made available on mobile platforms. Why shouldn't they be, when almost everything else contemporary students do in their lives can be mediated in such a way? The question is of providing appropriate and sustainable support during the process of making mobile delivery part of the core service. • My big concern is with whoever wrote this survey and their worldview of idle students wasting dead time and the agenda that underpins many of the questions and dimensions being used in this tool. The outcomes seem fixed and a really negative world

	view is inherently built in to many of the questions and scales. iOS is probably the worst possible thing that could EVER be brought in to educational settings. We need open standards not closed systems which are built specifically around turning students into consumers of apple data and 'needing' overpriced devices. Apple are essentially a vampire on music and education and their acolytes who promote everything as if apple are good or they are cool or edgy by owning an overpriced shiny thing should be told to unequivocally shut up and stop acting as apple marketers in educational settings.
Academics	• There should be new learning methods adapted to these new technologies. • Equality of access is one of my major concerns (people who can't afford high quality devices) and accessibility issues (visual and physical disabilities can make small mobile devices problematic), together with a need for very reliable high quality Wi-Fi broadband (which we don't have yet) • Lack of on-going support from my institution. Limited visual capability; input features restrictive for some mobility impaired -- even arthritis could put people at a disadvantage. Not all students are young technically savvy. • Mainly the difference in access to devices and the platforms that these run on. This leads to a discrepancy between students and a difficult position for those teaching, who are also familiar with a certain device. The expectation that everyone will have a mobile device that will enable students to access learning materials is still a bit of a jump I feel. • Its benefits must surpass costs for both students and institutions • Epilepsy - when it does not work. • Very dis-humanising
Students	• Not convinced that laptops and notebooks can be considered as mobile devices. • Great idea to use mobile devices in learning; however one has to tread carefully since they can be quite a distraction in class. It really depends on the user and how seriously they would use their mobile for learning among other social activities. • When using live interaction (voice especially, or live chat room) I have concerns about appearing "unprofessional" to an unknown audience of fellow students & tutors as some may also be potential employers. The flexibility to study away from an office makes the course accessible, but the study environment is often unprofessional. • Using mobile phones for learning can cause problems because at times the internet connections could be bad and some applications may not be suitable for every phone. • They can be fantastic for getting information and communicating remotely, but users of mobile devices must learn not to be distracted when using them. • It's a waste of time and resources investing into this, why use a mobile device when you can just as easily learn it from a computer. But this opinion could just be because I study a computing course in which being at a computer is usually an advantage when studying. • It has to be a level playing field for all students.

Q17: Please use this space to make any further comments.

Learning support / governance	• I think mobile devices will become as large a part of teaching and learning in the future as computers are today • Educational materials should include entertaining component (or play) • The outcomes of this survey seem to have been pre-determined and the dimensions along which it is being run strongly imply an agenda to 'promote ML'. Students are implicitly judged as lazy and ineffective - 'dead/idle' time says more about the survey

	writers' negative view of students than most other things meanwhile the technologies are constantly and inherently/naively linked to 'outcomes' or benefits as if there are some new mobile dues ex machina to be found in mobile devices. I couldn't answer many of the questions as they were too loaded to give an opinion or linkage too simplistic. This, unfortunately, seems to be another survey seeking to promote the latest tech and the importance of it with a really bad view of the user and how we much configure these idle students to use technology better rather than something that sees mobile use as ubiquitous and views the students as perhaps highly skilled users of mobiles who we could learn from rather than dictate to.
Academics	• I often put "unsure" or "don't know" when I wanted to put "it depends". For example, using ML could be very effective or very ineffective depending on how you used it, and some students would find it productive and helpful and others wouldn't, depending on their preferences. • Students are already using these devices in lectures but not for learning. This is very disrupting. I would rather keep lectures for those who want to attend. • It is necessary to build a culture so that there is a critical mass of colleagues using any new technology. If there is inconsistency in delivery students can get anxious; but colleagues all have different teaching styles which are all legitimate and these need to be accommodated. • Working with older adult learners presents different challenges from working with 'digital natives' • I think consideration of giving all students iPads with content etc is the way forward! • Great idea • The quantification of benefits over cost might be improbable • It will be very beneficial for all institutions. • The introduction might not be widely accepted • Could help learning more.
Students	• Mobile devices such as iPhone, iPads notebooks etc should be made much more procurable by price reduction so more learners have access because of their high usefulness. • Having course content available specifically for a mobile device is essential as not everyone can carry their laptop with them everywhere as they do their mobile.