

Learning on the move

Mobile technologies in business and education

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Executive Summary

Mobile technologies (mobile phones, personal data assistants, laptops, MP3 players) are commonplace in our society. Their availability at relatively low cost has contributed to social change, particularly with younger adults who use their mobile phones to maintain relationships unbounded by proximity. The relatively recent availability of 3G (Internet equipped) mobile phones and PDAs will increase opportunities for mobile learning and web-based information can be used to expand the learning experience.

Learning using mobile devices (m-learning) is not simply presenting traditional teaching via small, mobile devices. The interactivity of mobile technologies creates new teaching and learning opportunities more suited to a constructivist approach where the device is a tool for information and direction, but the structure of the learning is created by the learner.

In order to deliver learning via mobile technologies (m-technologies), educators therefore need to understand the opportunities presented by this medium, and be proficient in its use. In addition, materials presented via mobile devices should be designed for small screens. These imperatives demonstrate the need for 'behind the scenes' development and support to provide effective mobile learning environments.

The key features of mobile learning identified in this report are: its ability to provide learning that is 'just in time, just enough and just for me'; learning that is situated (typically in the field or at the workplace); and learning that is contextualised by mediation with peers and teachers. While mobile devices are making this type of learning easier to access, they are simply a tool for delivering the kind of learning that in past times could only be done with a knowledgeable tutor working on-site, alongside the student. Clearly tutors are too expensive to provide en masse, but mobile technologies provide the capability for high quality education tailored to the individual learner.

Is this hype, or is it happening? Informal learning using mobile technologies is already embedded in our daily lives. Millions of web-enabled phones are being used by learners (who may not be enrolled in formal courses) to seek information to build their own knowledge base. Use of mobile phones, PDAs and laptops in organisations is well-established and interviews with employers indicate that m-learning is integrated with the use of these mobile technologies at the workplace. Many education and training providers recognise the benefits of mobile learning, but the rate of adoption is slower. While this can be frustrating for the 'early adopter' educators and for students, there are good reasons for this, including: the age and digital capacity of teachers and trainers; the cost of providing mobile devices for staff and students; the slow rate of change in large educational institutions; and lack of availability of hardware and software designed with the education market in mind.

With consumers driving the global uptake of mobile telephony, and the growing functionality of these devices, it appears that m-learning is here to stay. Managing m-learning as a part of a suite of services that offer greater choice to learners will have benefits for providers as it frees teachers from delivery to focus on the management of learning, and will help learners to gain the skills needed by knowledge workers in the new economy.

A glossary explaining abbreviations can be found on p.66 of the report.

Introduction

The distinguishing feature of our society at the beginning of the 21st century is the rate of change. Technological advancements that allow fast communications and information processing are supporting new social patterns. As a result, communities are no longer simply geographical neighbours, and new 'tribes' are developing and disbanding according to interest, work patterns and opportunity.

Mobile information and communication technologies are important enablers of the new social structure. We are experiencing the first generation of truly portable information and communications technology (ICT) with the relatively recent advent of small, portable mobile devices that provide telephone, Internet, and data storage and management.

Even at this most basic level, the opportunities created by mobile technologies (m-technologies) can significantly reduce our dependence on fixed locations for work and study. It is predicted that the second generation of m-technologies, based on better operating systems, personal area networks, and smaller, more powerful devices will revolutionise the way we work and play. In order to meet the challenges of a mobile society, the education and training sector requires a good understanding of where we are now, and where we might go, in order that their response can be strategic, cost effective and aligned with the emerging needs of society. This report provides an overview of the current and near-future use of mobile technologies in business and education.

What is m-technology?

The following criteria were used to determine whether devices should be included in this report as m-technology:

1. Capable of providing communication and/or information functions
2. Small enough to be easily carried
3. Can be used (at least part of the time) without a physical connection to fixed power or telecommunications services.

A list of devices that are typically considered to be m-technology is included as Appendix A. Because of the rapid rate of product development, it is expected that this list will be quickly out of date, so readers are encouraged to scan the marketplace to identify product changes.

Drivers of mobile technologies

The Internet is effectively a Wide Area Network (WAN) for information and communication. Until recently, Internet access was restricted to fixed telephone connections at desk-based work stations, but this is rapidly changing as 3G phones (third generation, or java/web enabled phones) and 'smart' Personal Data Assistants (PDAs) are now firmly settled in the market, and are selling as fast as they are produced.

The availability of mobile and wireless devices is enabling different ways of communicating. Mobile communications are no longer restricted to companies that can afford large investment in hardware or specialised software. Individuals now have easy

and inexpensive access to mobile telephony, and the cost of mobile access to the Internet is reducing each year. Mobile technologies have enabled a new way of communicating. Young people, for whom mobile communications is a way of life, are 'always on' and connected to geographically-dispersed friendship groups in 'tribal' communities of interest.

The 'always on' generation is, to a large degree, driving development of consumer communication technologies – as can be seen from the rapid and unexpected adoption of SMS as the communication tool of preference for Generation Y (young people aged 10-25) and the Millenium Generation (those born in the last decade). These two groups are expected to be the key drivers of wearable Personal Area Networks, which are currently in their infancy but have enormous market potential.

Mobile or professional employees are driving the development of PDAs and 'smart' phones (which combine Internet and PDA capacity) through demands for greater integration of information, data management and communication.

"With an increasingly mobile workforce, from salespeople to IT professionals, people are craving to have more information available at their fingertips."
(Kossen, 2001)

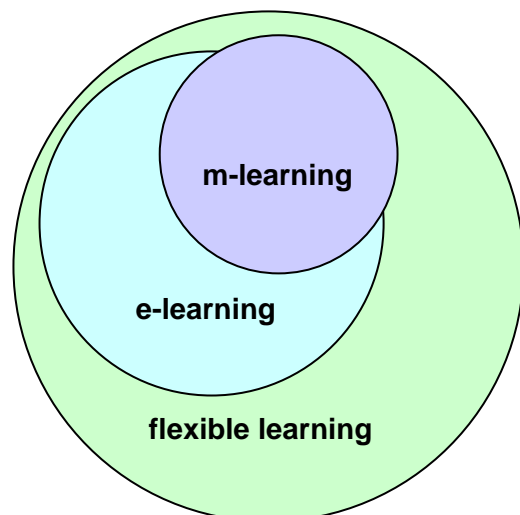
Industries and organisations with specialist needs are the other significant driver of mobile products. New products are generated through collaboration with hardware and software developers to create solutions for specific enterprise or industry uses. Sectors that have made a notable contribution to mobile product development include: health, resources, agriculture, emergency services, government, retail and transport.

The education sector tends to be a secondary adopter of mobile technologies, developing learning applications after the efficacy of the technology has been demonstrated in other sectors.

E-learning, m-learning and flexible learning

Wikipedia (<http://www.wikipedia.org>) describes e-learning as 'computer based training which incorporates technologies that support interactivity beyond what would be provided by a single computer'. The Australian Flexible Learning Framework (Framework) defines e-learning as 'a broader concept [than online learning], encompassing a wide set of applications and processes which use all available electronic media to deliver vocational education and training more flexibly' (Backroad Connections, 2003).

In practice, e-learning tends to be delivered via Internet and CD-ROM, and can be accessed on desktop or mobile computers. The advent of mobile technologies has created opportunities for delivery of learning via devices such as PDAs, mobile phones, PC Tablets and laptops. Collectively, this type of delivery is called m-learning. While m-learning is often thought of as a sub-set of e-learning, the emerging potential of mobile technologies tends to indicate that m-learning, while mostly situated within the e-learning framework, also has links directly to the 'just enough, just in time, just for me' model of flexible learning.



As the capability of mobile devices increases, and electronic learning materials are broken down from large file formats into smaller learning objects that are compatible

What is the ideal type of content to be delivered via mobile learning?

Minimal! It can be any content, but it can't be a lot. I don't think m-learning is e-learning lite, however. I think it's a different relationship. For one, it's closer to performance support. What it can and should be is an adjunct to some initial concept presentation, but one that keeps the learning active over a long period of time with smaller bits, something we don't do with e-learning.

Given what we know about learning, we should be working on small bits over time regardless. With a mobile solution, we could be doing that and using the events in our lives as the practice, not some artificial simulation.

Clark Quin (in Kaplan-Leiserson, 2005)

with standard operating systems and applications, the distinctions between e-learning and m-learning will diminish and possibly disappear.

The rate of consumer adoption and the increasing capacity of mobile digital technologies make m-learning an exciting teaching and learning option. But designing and developing learning tools based on these technologies is not without its challenges. Manufacturers are constantly creating new and better products and consumers are finding new uses for technologies as they come onto the market. The result is rapid product change that can render a particular platform unfashionable or obsolete in less

time than it takes to develop an e-learning application. The challenge for educators is to identify a platform that will be stable long enough to realise a return on their investment.

Excitement about the potential for m-learning needs to be tempered with the recognition that m-technology does not necessarily replace existing technologies. After all, books are an excellent technology for storing and accessing static knowledge. M-learning (like e-learning) is not well-suited to electronic 'page turning', which critics describe as 'e-reading'. Interactive technologies provide new learning environments and should create rich, interactive experiences tailored to the needs of the learner.

Other definitions relevant to the e- and m-learning fields are 'online learning' which refers to learning that occurs exclusively via the Internet; and wireless learning (ie, delivered on wireless devices).

Structure of the report

This report presents the findings from both desk and (limited) primary research into current and forecast applications of m-technology and m-learning. It considers the perspectives of businesses, manufacturers and m-learning providers against academic literature and web-based information to provide an overview of the current mobile environment and how it is being adapted for education and training purposes. The main sections of the report are:

M-drivers: what drives the development and adoption of mobile technologies and what this means for m-learning.

M-technologies in business: the uptake of mobile technologies in business, looking at both the 'push' effect from manufacturers and the 'pull effect' from businesses seeking a competitive edge through development of their e-business capacity. This section introduces m-learning at the workplace and examines the interface between e-business, m-technologies and m-learning.

M-teaching: the experience and the future: m-learning from the perspective of educational institutions. It looks at how m-learning differs from e-learning, and the effects of 'consumer push' on education and training.

M-learners: the consumer as a learner: the effect of the consumer society on mobile technologies and life-long-learning and the implications for development and delivery of m-learning.

Mmmm, where to from here? Summarises the findings in the report and identifies key issues for policy makers and m-learning providers.

Definitions

Key definitions are shown below. A detailed description of mobile learning devices is presented in Appendix A.

M-technologies

The following m-technologies are included in this report:

- CD-ROM and DVD
- flash storage devices/drives
- Global Positioning Systems (GPS)
- laptops or notebooks
- mobile computers
- mobile telephones
- MP3 players
- Personal Data Assistants (PDAs)
- portable media players
- portable video game devices
- tablet PCs.

Convergence

The term 'convergence' is used in many different fields and contexts. Its use in this document primarily refers to the technical sense: the trend for some technologies initially having distinct functionalities to evolve and overlap (Wikipedia, 2005).

Wireless, networks and smart technologies

Reference to the literature and media discussions about m-technologies will uncover frequent use of the terms 'wireless', 'network' and 'smart technology'. An explanation of these terms is included here to aid understanding of this topic:

Wireless technologies are simply those that enable communication without cables or cords, mainly through use of radio frequency and infrared rays (Wikipedia, 2005). Many wireless communications are managed via networks.

Networks are computer networks that can be Wide Area Networks that cover large geographical areas (the Internet is one example). Local Area Networks (LANs), which typically service a single organisation and are often connected to WANs to communicate with users in other locations. Less commonly used at this stage, but likely to be more frequent in the future, are Personal Area Networks (PANs), which, using Bluetooth (defined by Wikipedia as an industrial specification for wireless Personal Area Networks) or infrared technologies, allow devices to talk to each other over short ranges.

The word '**smart**' is used in different ways for different technologies. The most relevant use for this report refers to the integration of web with devices that had not previously

used this technology – such as telephones and PDA devices. Future **smart** mobile applications are likely to include clothing and other wearable devices such as watches.

M-drivers

Mobile technologies are a product of their age. Social change, technological advancement and globalisation have all influenced the development of m-technologies. To understand the potential of m-learning, we need to consider what is driving the adoption of mobile technologies and what these drivers indicate for future trends.

The main drivers that will be considered in this section are:

1. Social demographics and their behaviours

The Baby Boomers, Generation X, Generation Y and the Millennials: how they behave, when they learn, and how their behaviour is influencing product development.

2. Technologies

The trend to devices that are smaller, more powerful, have longer battery life, based on operating systems designed for mobile use – and the convergence of different uses: what are the trends and what do they indicate for the future?

3. Globalisation

Who decides what is produced? Where do learners fit in the product development lifecycle?

Social drivers in 21C

Baby Boomers, Generation X, Generation Y and the Millennials, the main demographic groups in today's society, are imprinting their shopping, social and work patterns on the development of technology and how technology is being used as a learning tool. The following description provides an outline of each of these groups from the perspective of mobile technologies and mobile learning. There is no definitive date range for these groups so indicative dates have been provided.

Baby Boomers are the children born in the post-World War II economic boom. They are the largest age group in our society and have been dominating the market trends for two decades. Boomers tend to be late comers to computer technologies and, while they have adopted mobile phones with enthusiasm, their use of SMS and PDA devices is limited. They grew up in an era of long-term jobs and are still adapting to the process of life-long-learning to keep their skills relevant to the labour market.

Generation Xers are the children of the early Boomers. Born in the 1960s and 1970s, their impact on the markets has been decidedly less than their parents, and to some degree their needs have been overshadowed by the dominance of the Boomer generation. However Generation Xers are now in their peak working age and, with two incomes and plenty of cash, they are time-poor parents of small children (Gen Xers were the first generation to significantly delay having children). Generation Xers tend to move jobs frequently and are comfortable with work patterns that require continual skill development, so they are likely to be studying, often by distance or on-line.

Generation Ys are the generation born in the 1980s and early 1990s, typically children of the 'late breeding' Boomers or of the early Gen Xers. They are teenagers and young adults who have grown up in an environment of electronics and consumer choice. Studying and living at home longer, they are more likely to spend their money on new electronic gadgets than investing in a home deposit. Most Gen Ys have not thought

about having children so with good jobs and cash to burn, they tend to be early adopters of new technologies. The pervasiveness of mobile communications means that they can maintain social connections that are not determined by proximity, which allows the development of tribal groups based on mutual interests.

The Millennials are children born in the late 1990s and early 2000s. They can be children of Boomers, Gen Xers or Gen Ys and are 'born to be wired'. Unlike previous generations whose affluence determined their access to computers, Millennials are likely to have Internet-connected computers in their classrooms, their own email addresses, and parents who value time with their children over housework. Sophisticated electronic devices are normal tools for these children, who are polyfocal¹ (able to concentrate on a number of tasks at the same time) and, because communications allow their communities of interest to extend beyond their immediate neighbourhood, they are more accepting of different ideas and different cultures than earlier generations.

New strategies for engaging Boomers, Gen Xs, Gen Ys and Millennials

	Boomers	Gen X and Gen Y	Millennials
Style	Structured Planned	Spontaneous Participative	In control Tribal
Content	Technical Provable	Experiential Observable	Abundant Surfable
Process	Auditory Facts	Visual Feelings	Contextualised Savvy info seekers
Action	Long term needs Bank balance	Short term goals Life balance	Change management Community balance

(based on McCrindle, 2003)

Mark McCrindle, (cited by Ragus, 2004a) states that in the next 10 years, 60% of the Gen X and Gen Y population will choose to work flexibly. These generations do not want to work 'nine to five', rather they want to get it done in their own way, in their own time and in a way that suits their lifestyle. They do not want written text or manuals because they are very visual, insisting on pictures, icons and multimedia. They will move in and out of education, work and employment.

Technologies that have allowed us to have knowledge at our fingertips also support the development of a user-centred approach and affect the way we learn. Stahl et al. (1995, in Geddes 2004) have identified that learner-centred interaction results in learners being more engaged and helps to develop personal intellectual structures that foster a deeper understanding of the content at hand. It is often claimed that the quality of learning, enabled through knowledge-rich, collaborative, and situated learning environments, has accelerated the rate of knowledge acquisition by younger generations.

¹ During the preparation of this report, a number of colleagues expressed concern that the polyfocal learning preferred by Gen Y and the Millennials reduced their capacity or experience of deep learning. While this may be the case, the use of polyfocal learning techniques is not necessarily 'shallow'. Schwab's seminal work on polyfocal conspectus, in which issues are examined systematically from many perspectives, provides a deep understanding of issues (Schwab, 1978). Likewise, Robinson (2003) reminds us that 'course and resources need to be well planned and provide opportunities for deep learning through reflection, analysis, evaluation and making judgements. Materials need to be accessible, interactive, comprehensive and well designed.' Mobile technologies can help to provide accessible and situated learning opportunities that appeal to polyfocal learners.

Geddes (2004, citing Spiro et al., 1991) observes that learner-centred collaborative approaches are also well suited to ill-defined knowledge domains as they allow students to discuss complex situations and to resolve ambiguities which are common in these domains. Thus the technology supports better understanding of nebulous concepts, which, in turn, generate the development of more sophisticated technologies.

Technologies

Mobile devices currently on the market are seen by some to be the last examples of the first generation of mobile technologies. Today's mobile technology is derived from separate computing, telephone and PDA platforms. In some devices, mobile telephony and PDA applications have converged to the extent that both uses are intuitive and effective. However, even these sophisticated devices are 'Stone Age' compared to the capabilities of devices that use operating systems designed to integrate standard computing applications, mobile phones and organisation of personal data. The anticipated development of new generation mobile operating systems that will provide seamless phone/computing/ PDA, with longer battery life and expanded Personal Area Network capability, will create mobile computing and communication opportunities that today's users can only dream about. The rate of development of mobile technologies indicates that the second generation integrated devices will be available in two to three years.

As technology evolves, so will the way it is used. According to Jackson (2003), seemingly obvious developments like the expansion of SMS to MMS (Multi Media Messaging) underestimate the potential for the way information is received and handled.

The main drivers in the development of mobile technologies are organisations and consumers, but the separate effects of these two drivers are difficult to isolate. Both organisations and consumers purchase mobile technologies and are therefore primary drivers of product development, but organisations and individuals are also consumers of the services that are enabled by mobile technologies, thus creating a secondary driver.

What percentage is purchased for business purposes and what percentage is purchased for consumer use? There is such a cross-over between personal and business use we're unable to tell them apart. Higher end products (Bluetooth or wireless, products with extra security, or products containing enterprise solutions) are marketed only to business clients but the simplest phone under AUD\$100 can be used for business as well as personal purposes.

Nokia (interview, 2005)

Callahan (2004) describes the combination of business cost efficiencies and consumer demand for faster, more accurate services as key drivers for the development of mobile technologies within organisations. He illustrates this with an example from the health care sector in America. The primary driver of health-management technologies in the United States (US) is the Federal Government's policy to computerise all medical records within ten years (with the aim of making hospitals more efficient, reducing medical errors and lowering health-care costs). The secondary driver in this case is baby boomers who are unwilling to wait for test results and are demanding more efficient medical care.

The business case for mobile technologies is becoming increasingly attractive, particularly for organisations that benefit from their staff having up-to-date information or email communications when away from fixed workstations. The reducing cost of mobile devices; the efficiencies that come from staff having instant access to

databases, email, web and multi-user diaries; and the increasing availability of 'off the shelf' applications are bringing mobile technology into the business mainstream.

Reduced costs of m-technologies also provides better access for learning purposes as mobile technologies develop capabilities similar to desktops – at significantly lower prices.

Integrated technologies

Visually and functionally, most mobile devices for the consumer market are recognisable as phones or PDAs. However, there is fierce competition in the research field to develop technologies that can be worn, or integrate with other materials and devices.

The following list provides a taste of what is already on its way:

- Wearable devices include: wrist phones (DoCoMo), pendant phones (Siemens) and jewel phones (Nokia/Vertu).²
- Glasses upon which video output is projected, or which project an image in front of the wearer. Manufacturers promote their use in personal entertainment, film, surveillance, military, airline and industrial applications. Some brands are principally aimed at mobile-phone users, and increased demand is expected from this market as MMS becomes more popular. High-tech Japanese handsets now regularly feature a flash memory chip slot and have the ability to display MP4 files (a format that compresses films or television shows into a form that can be viewed on a small screen).³
- Smart textiles such as clothes that monitor heart rate, blood pressure and other vital signs and sound an alarm if there is a problem. Tiny sensors printed on the fabric allow doctors to monitor patients without having to keep them in hospital. These products have other applications, such as warning firefighters that they are breathing in too much smoke or alerting soldiers to chemical weapons in the environment.⁴

Levi Strauss and Philips Electronics introduced the first wearable electronics garment to consumers in 2000. The jacket incorporated a mobile phone, collar microphone, headphones and an MP3 player, but difficulties with washing the garment led to it being removed from the market.

- Soft devices such as roll-up keyboards and screens, and devices that project screens and keyboards and sense movement onto workspaces. This allows highly portable 'touch' screens and keyboards.
- Microsoft has been awarded a patent for using human skin as a power conduit for Personal Area Networks to allow a single data input or output device to be used by multiple portable devices – for example a phone, MP3 player and radio all accessing the same speaker.⁵
- Wearable Bionics, such as synthetic vision from auditory video representations.⁶

² http://www.e-principles.com/article_25.htm

³ <http://www.timesonline.co.uk/article/0,,3-1547678,00.html>

⁴ <http://news.scotsman.com/features.cfm?id=1114102003>

⁵ http://news.com.com/Microsoft+patents+body+power/2100-1014_3-5244766.html?type=pt&part=inv&tag=feed&subj=news

⁶ <http://www.seeingwithsound.com/voice.htm>

Palm Australia (interview, 2005) described their operating environment as one in which relatively standard products are supported by a very active third party community that develops software and add on hardware to work with their devices. Using this approach, producers of the hardware and operating systems can minimise their costs and maximise their effect through product development partnerships that cater for user needs in large and small markets.

Nokia (interview, 2005) reflected that demand from consumers and businesses strongly influences the type of product being developed, with the common requests being: easier to use, smaller, faster, smarter and greater security. This has resulted in advancements such as layers of security, Bluetooth, car and business kits, hands free and infrared/data cables. When asked about the future applications or capabilities that are planned for existing products, the response was: 'smaller, faster, better, cheaper, and more wireless technology to send bigger files faster'.

What does this mean for social trends?

The ubiquity of mobile communications has already led to some new patterns of behaviour becoming embedded in our social and work behaviours. The boundary between work and leisure is blurring, with mobile devices enabling travelling time (on buses, trains and planes) to be used for both business and work pursuits.

Capturing and sharing of images, audio, text and other content on camera phones is becoming vital to how young people interact (Satchell in Goggin, 2005). Recent European research identified that text messaging is a way people give gifts to each other - a pattern of social exchange (Goggin, 2005; Taylor and Harper, 2002 in Attewell 2003).

"The ultimate affirmation of an event having occurred is its being captured, shared and distributed by mobile phone. It completes the experience."

(Satchell, 2005)

The expansion of opportunity to communicate, using better and more intuitive devices will continue to both drive and support social and workplace change.

Globalisation

The globalisation of the economy is the third driver of mobile technologies. Giant corporations with the resources to invest in accelerated research and development, low cost production bases, and marketing reinforced by the Internet and 'tribal' communication networks are contributing to rapid technological development.

The speed of change in the market place is mirrored in workplaces, which are – in economic terms – simply another market. The increased requirement to undertake personal learning to maintain a competitive advantage in the global economy has resulted in the average adult spending 15 hours per week conducting personal learning (Falk and Dierking, 2002, in Geddes, 2004), typically at irregular times and places (Sharples 2003, in Geddes, 2004).

Globalisation has also produced systems that are standardised across cultures. The new tribalism is based on interest, not proximity, and the global village is facilitated through easy access to communications. International students are a growing education market and mobile communications are a very important part of this group's ability to stay in touch with people from similar cultural backgrounds and to maintain contact with friends when they return to their country of origin.

M-technologies in business

E-business, that is business conducted electronically, is a fundamental part of business in today's environment. From simple web-based banking through to real-time supply chain and logistics management, an understanding of electronic commerce is a critical success factor for most businesses in developed economies.

As can be seen from the promotional material on the right, e-business can support all aspects of the production, promotion and supply chain. The application of mobile technologies to e-business presents new issues and opportunities.

This section of the report looks at what the academic literature and web are telling us about mobile technologies in organisations. This information is then compared to the findings from interviews with Australian businesses that use mobile technologies. Finally, these findings will be considered for their application to mobile learning at the workplace, and will consider whether mobile technologies contributes to the development of a learning culture within an organisation.



<http://www.academyinternet.com>

Typical uses of m-technology

Business applications for mobile technologies tend to be derived from four sources:

- custom built hardware (such as NEVE's personal GPS device to collect data about travel patterns for transport research and planning)⁷
- custom built software (such as the Finnish STTV/Nokia joint venture)⁸
- modified software for existing devices (mainly PDA and web based training products)
- unmodified proprietary and open source software for existing devices (see Appendix B for an example of Palm-based curriculum).

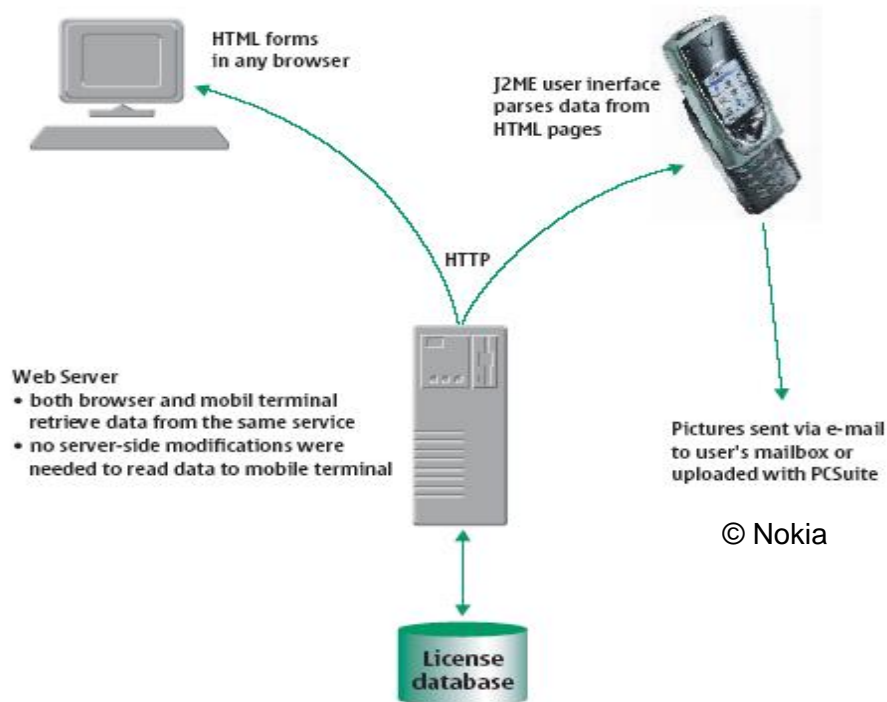
Some devices such as tablets and mobile computers have been predominantly used in the business environment, and are likely to remain in the business sector until lower prices make them more accessible to consumers. Others, such as GPS and laptops originated in the military and business but are now in common consumer use, and others (games and MP3 players) had their origins in the consumer market and their application to the work environment is now being explored. Mobile telephones started as a business tool, but rapidly spread to the consumer market where they are now the dominant technology for personal telecommunications.

A search of the Internet reveals steady development of new mobile devices aimed at a wide range of markets. Small mobile communications and storage devices were advertised for applications such as: risk assessment, triage, fire inspection, bylaw enforcement, building inspection, city engineering, security, surveillance and military purposes. The illustration below, identifying the elements required to support mobile

⁷ www.neveits.com

⁸ http://www.forum.nokia.com/info/sw.nokia.com/id/f6d1bbf3-7d14-4673-89f4-45c0e58857b9/Widian_case_study.pdf.html

work in joint venture between Nokia and the Finnish Health Agency, shows a web-based mobile work environment.



The use of Java technology to access data from web servers means mobile phones can operate as searchable computers. Health inspectors at the Finnish Health Agency STTV access their IT infrastructure through software that can access web servers in real time and search and record data about restaurant health inspections.

http://www.forum.nokia.com/info/sw.nokia.com/id/f6d1bbf3-7d14-4673-89f4-45c0e58857b9/Widian_case_study.pdf.html

Because of the popularity of mobile phones as peer to peer communication tools, particularly for young people, the health sector is exploring how mobile phones can be used to provide patient feedback. For example, the Murdoch Children's Research Institute is using SMS to track predictors of adolescent depression.

Young people are difficult to engage in research and other studies have tried to use questionnaires or diaries, daily diaries and found that quite tough. And the reason we're using mobile phones is because it's a much simpler, easier way of getting someone to keep a diary than asking a 14 year-old boy to keep a diary for me every day. It's not going to happen. (Dr Sophie Read quoted at

<http://www.abc.net.au/rn/science/ss/stories/s1357807.htm>)

The retail and transport logistics industries were early adopters of mobile technologies, developing custom-made devices specifically for their industries.

Australian transport authorities are currently trialling handheld devices for remote inspection of ships for seaworthiness. The PDA stores the data, which includes free text, and the database is updated using hot-sync. In the past all documentation was done on paper, and then manually entered onto the database. (Bright Cookie, 2005, personal communication).

More recent advances in consumer handheld technologies have allowed businesses greater access through adaptation of standard devices. Bowles (2001) identified typical uses for mobile technologies in Australian retail businesses (see below). These descriptions are insightful as they show both the functionality and opportunity provided by mobile devices:

Sales – allows access to customer information and service history, customer surveys, inventory levels checks in real time, ordering, collecting customer signatures electronically, and authorising and checking credit. This reduces costs such as call centre, data entry, inventory delays, improves knowledge of customer, and reduces turnaround time.

Mobile access to management and operational systems – allows businesses to leverage existing IT systems, and therefore provide access to email, legacy systems such as SAP, Internet surfing, and indicators so that staff can receive information as required from any location.

Field Service – merchandise or field sales jobs need to be able to view client contact details, review client history, report and resolve problems, and record resolutions, actions and billings.

Capture and processing of additional data – electronic authorisations using mobile devices allows the use of intelligent forms and prompts (eg a reminder that the customer has five lines, if they buy one more, they qualify for extra benefits).

Businesses interviewed for this report used mobile technologies in the following ways:

Accessing company email through web
Backing up information
Calls
Commercial sales
Communication
Connect to reminders
Contacts
Daily work for managers and mobile staff
Data storage
Diary management
Digital camera/video camera
Editing newsletter
Email
Everyday use, replacing the desktop
General mobility
GPS
Graphic intensive applications - mapping
In planes
Information and training
Intranet and Internet
Learning resource
Link with Internet
Marketing tool
MMS
Music around office (private consumption)
Navigational
Organisers: diary/email
Personal organisation and communication
Education (to inform about industry)
Receive and send info
Record meeting minutes
Sales
Server and databases
SMS
Software installation
Strategy games and learning
Transporting files
Working away from docking stations

M-commerce in Australian businesses

One of the aims of this research was to separate the 'hype' and the reality in the use of mobile technologies. Web searches provided much information about what could be, or is already here, and interviews with businesses identified what is actually in use. There were few significant differences between the two and it appears that take-up of m-technologies, and of m-learning at work, is seen as a cost effective option that is well-received by staff, and the organisations interviewed for this research are looking positively at new opportunities from future mobile technologies. Bright Cookie's Leo Gaggl reflected that many of the problems with earlier versions of work and learning on mobile technologies are now being overcome:

Web based SMS worked well for getting messages to students, but the students weren't able to respond. This will be solved soon. Also a flash-based mobile interface is now in the pipeline and the technology is now moving quickly to respond to the increasing speed of uptake (2005, personal communication).

The businesses that participated in the interviews used a wide range of technologies, with the most common being laptops and mobile phones, although CD-ROMs, DVDs, PDAs and portable media players were also used by most businesses. Tablet PCs were least used.

Examples derived from Internet searches showed the following uses:

- PDAs to support sales staff and to access emails while out of the office.
- Reduction in the use of laptops and notebooks to graphic-intensive applications, with increasing use of PDAs and smart phones for simple computing tasks.
- Increasing use of Tablet PCs for mapping and graphic applications.
- Rapid expansion of the use of MMS (videos and still images) to demonstrate features of products to customers, or use of mobile phones to record field information, relay it and discuss (Goggin, 2005).
- Museums are replacing audio guides with information streams that can be downloaded via wireless onto visitor phones. Visitors benefit from guides that can offer an unprecedented level of personalisation and self-direction (Geser and Pereira, 2004).

Has the use of mobile technologies increased business efficiency? The businesses interviewed for this research saw significant benefits from mobile technologies – the list below shows common reasons for business efficiencies from m-technologies:

Optimising your Sales Workforce through Mobile Learning

Using their PDAs, learners can create a self-prescribed profile, based on their specified interests, business unit, management level, and job role.

The learner then indicates what type of material they want based on geographic region, customer accounts, subject expertise and current industry challenges. This is then combined with an existing database, perhaps created from HR material, corporation communications, or industry news.

Known as profiled notification, when a new piece of learning material becomes available, the learner is instantly notified, either through an email or an SMS to their mobile device. And, if their devices have the technological capabilities, learners can also download audio and video versions of the material.

Anytime learners are sent a notification, they know there is important information waiting for them—information tailored specifically and relevant for their interests and needs.

Christopher von Koschembahr (2005)

**Worldwide Mobile Learning Executive:
IBM**

- Flexibility, speed, and more efficient networking, which allows access to large numbers of staff throughout world.
- Provision of efficient customer service.
- A more efficient working environment, with less manual paperwork – work can be done faster, more flexibly, and with greater levels of accessibility.
- More efficient training, saving time to inform staff about new products and processes.
- Improved storage and backup of data, with much of the risk removed.
- Saving of time and money.
- Creating greater responsiveness to change.

These outcomes were based on carefully thought-through business cases that considered: markets, productivity, professional development, staff morale, risk management, knowledge management, cost, and responsiveness to a dynamic operating environment.

The value of mobile technologies was further tested by asking scaled questions about business benefits in four categories: finance, staff satisfaction, competitive edge and business culture. The highest ratings were for financial and business culture, but all categories rated at least 4 out of 5 as can be seen in the table below.

Category	Average rating
The financial value of mobile technologies to the organisation	4.6
The value of mobile technologies to staff satisfaction	4.1
The value of mobile technology in establishing a competitive edge	4.0
The value of mobile technologies in creating a business culture that values new knowledge (a learning organisation)	4.6

[Scale 1= not important to 5= essential]

Businesses interviewed for this report saw the next evolution of mobile technology applications for their businesses to be:

- Greater choice in hardware, resulting in a better fit between commercially available devices and the needs of individual businesses.
- More customers using phones, PDAs, Internet and email to order and make bookings.
- Blended training with an increased proportion of learning delivered on mobile devices.
- Faster, more efficient technology as part of a normal work environment.
- Simulated and interactive training using games to teach problem solving and resolve issues.
- Convergence of technologies and increased use of devices that can do more than one thing.
- Increase in wireless hotspots to provide improved access to the Internet from outside the standard work environment, so that workers are not restricted when travelling.
- 100% mobile:
If we moved offices again we would commit to 100% wireless network. It makes more sense as we have a lot of core infrastructure already in place. This would also allow flexibility to increase PDA use which would result in increased access to email from outside the office, and automatic synchronising of remote data with the server (Australian Electronic Commerce Centre).

M-business, new opportunities, new issues

Mobile work, like electronic work before it, has created new opportunities for businesses and for individuals at work. However, new opportunities also mean new data systems, new ways of communicating, and new challenges for managing and supporting the people using these technologies.

MOPAS, the long-standing Scandinavian research project into mobile technologies at the workplace, identified that the use of mobile devices at work required new ways of organising and working. The project identified specific issues:

- *Mobile work is often more costly to establish* and requires good ICT systems to avoid disruption of sessions, which require sustained communications irrespective of the number and type of input devices, with no technical breakdowns.
- *Mobile work is considerably more situated than stationary work* and it is almost impossible to plan, since the precise unfolding of events in remote settings cannot be anticipated. At the same time, experiences made during mobile work need to be captured for the benefit of co-workers.
- *Work in remote settings renders familiar navigational mechanisms less usable.* Navigation relies on the physical and logical layout of resources and in the case of mobile work these are not available. Therefore, mobile work requires improved support for remote-navigating of human and information resources.
- *Much mobile work is co-operative.* At the same time, mobile workers have less awareness of the ongoing activities in the organisation. Since the abilities and capabilities of co-workers to participate in synchronous co-operative work are hidden, session control mechanisms are necessary.
- *Business-critical work implies severe security concerns.* The risk of losing valuable or confidential business data is greater when workers rely on mobile devices that can easily be misplaced or stolen. Likewise, making web-based data available remotely can have greater security risks than LAN applications. Mobile work, therefore, requires mutually secure easy-access (Kristoffersen and Ljungberg, n.d.).

An engineer may be called to repair a machine that he hasn't seen, let alone worked upon before. Using a videophone he will be able to use the camera in the phone, consult with a colleague and show the fault "live." Alternatively, where possible, a colleague in the office might send a piece of video to show the engineer how to fit a part or repair it Dineen (n.d.).

Opportunities for low-cost telecommunications to support the development of mobile technologies are restricted in Australia due to the nature of the telecommunication industry which does not allow switching across wireless, cellular, wired and satellite networks (eg data casting cannot be done on TV frequencies). Other countries (Korea for example) have implemented network switching arrangements as a national competitiveness imperative. Network switching is important to avoid dead spots and dropouts that interrupt real-time work. Switching also allows devices to use fast wireless networks, cellular, wired or satellite data transmission as the situation requires. Restricting transmissions to one network creates inefficiencies and higher operating costs (Wilson, citing Bowles, 2005).

Drivers of m-learning in business

Do businesses use m-learning? If so, what is driving their investment in this mode of learning? It is well established that good businesses value training. More important than the outcome for individual businesses, a skilled workforce is essential to creating Australia's competitive edge in the new economy.

The web search and primary research identified that organisations are using mobile devices for learning and unlike early computer-based training that required huge infrastructure and support budgets, the evolution of web-enabled handheld devices allows even small enterprises to access learning online, and reduces the dependence on expensive, custom-designed databases.

The use of mobile technologies for learning raises a number of questions about the nature of learning. Educators coming from a traditional delivery perspective may consider that any learning tool provides an opportunity to emulate the teaching process – indeed, mobile (and e-learning and flexible learning) can do this, but the nature of mobile technology allows different, more constructivist approaches, where the device is a tool for information and direction and the structure of the learning is created by the learner.

Workplace learning, because it is situated, and because it builds on the existing knowledge of the worker, can be seen as constructed learning. The use of mobile devices as learning tools allows site-based learning, thus increasing the relevance and retention of knowledge for the learner.

Learning organisations are skilled at acquiring information, storing it in memory, and retrieving it selectively to guide appropriate courses of action.

Unlike individual learning, which can be acquired and held independently, organisational learning requires communication and exchange of information among organisational members, resulting in the sharing of common frames of meaning.

Saengdaeng (n.d.)

Learning that occurs in the field, that delivers the information needed at that time, and that enables communication with peers and supervisors to resolve problems is seen as a cost effective, immediate solution to training needs.

An added advantage is that the data management systems that support m-learning and e-learning can be used to collect information about how people learn electronically – by tracking the way information is accessed. The data that would be useful to organisations includes: the nature of the information accessed; the frequency of access; the length of time spent in learning sessions; and the process used by learners to find a particular piece of information. Tracking the way in which people use their mobile devices provides a rich source of information that will help organisations to anticipate training needs and build knowledge. Analysis of learner access and usage patterns can also help in the development of better learning opportunities.

The following section looks at organisational experience of mobile technologies for learning about the job, and for learning about the device – the conclusion is that workers are comfortable using m-technologies for both training and work.

M-learning at the workplace

An earlier section of this report looked at m-commerce in Australian businesses. This section examines the use of mobile technologies for learning at work, which tends to fall into four main applications: referencing information, learning about the job, collaborating with co-workers, and learning about the mobile device itself.

Businesses interviewed for this research used the following mobile technologies as learning tools for staff:

- CDs for multimedia learning.
- Laptops for tutorials on how to use equipment and software.
- DVD/CD-ROM-based training packages.

OneSteel Whyalla said that its use of mobile technology depends on cost:

It's a great benefit to be totally mobile – efficient and faster – however it is not a core part of business. It is important in terms of safety that we get the information out there quickly and efficiently. Moving towards more mobile technologies would be a really good influence in changing the whole culture of the environment in this business.

Businesses were using mobile technologies both for learning about the devices and their uses and to learn about other things.

Food service manager: Staff need to have a learning package that they could 'pull out at a moments notice, in a break or quiet period and undertake some study'. (Ragus 2004b)

Recent work by Marcus Ragus (2004b) for a Framework New Practices in Flexible Learning Project tested the use of PDAs in four different work environments (botanical gardens, nursing home, food and hospitality and workplace assessor). The Royal Tasmanian Botanical

Gardens trial found that simultaneous personal development for staff in separate organisations is possible and that such strategies can be designed and targeted for a mixed audience comprising managers, teachers, ground staff and apprentices. The nursing home trial used integration of PDAs into the general on-site training of the nursing staff through the use of simple resources created using Microsoft PowerPoint (Ragus, 2004a).

The food and hospitality sector trials grew from a need to develop interesting, interactive resources for use by trainee bar and beverage staff (the food and hospitality industry is introducing PDAs into restaurants and cafés as wireless ordering systems) and demonstrated the application of an existing PDA image program to create a learning resource for the bar and gaming certificate.

Workplace assessment practice trials were undertaken within the horticulture sector with two specialist assessors. The aim was to use PDAs and a peripheral plug-in camera to capture evidence of assessment at remote workplaces where it is imperative for assessors and learners to be able to operate with a high degree of flexibility in both delivery of learning and the materials and equipment they carry with them (Ragus, 2004b).

Deviney and von Koschimbahr (2004) describe the situation in a major electronics retailer that uses a mobile learning program to train new sales associates. Traditionally, new employees spent several hours in a back office reading a binder or accessing a learning portal to study various products. The products are not in front of the employee, and there are often hundreds of products to understand. With m-learning, the retailer can equip its staff with a hand-held PDA and bar-code scanner so that employees start and finish their training on the sales floor. During down time, they find a product, scan a bar code and take a five-to-ten minute training module in front of the product. This application would also create learning opportunities when dealing with customer enquiries. When a customer expresses interest in two products and asks about differences, the sales person scans the bar codes of the two products, observes the differences between the products and helps the customer make an informed decision with just-in-time information.

South Australia's Department of Transport, Energy and Infrastructure is currently implementing mobile communications for traffic signal maintenance workers. Field staff had previously been using laptops, but had to wait until they were back at the office to update communications. The introduction of communications cards is enabling real-time communication through automatic redirection of fault logs straight from signal switchboards to field worker laptops. This process also allows the capture of fault and

repair data, which needs to be recorded for legal reasons. Mobile phones were considered for this task, but at this stage do not have the bandwidth to deliver sufficient data at the required speed.

M-technologies driving the learning organisation

The promise of mobile technologies helping to generate a learning culture within organisations is pervasive in the literature. To what degree is this realistic, or is it just early-adopter hype? Articles about the link between mobile technologies and learning organisations appear to fall into three categories:

- a database focus that captures organisational knowledge
- a human systems focus that allows synchronous communication and information sharing at the worksite
- a learning development focus that suggests that learning about new technologies generates a more general drive for learning.

The database focus has, to a large degree, become the 'accepted wisdom' in organisations that value knowledge, and these organisations are driving the development of data management systems to capture and manage knowledge. The inclusion of mobile technologies in these systems can, because of the potential to record keystrokes and hyperlinks, make the process simpler and more manageable than trying to capture knowledge from other communications such as fax or email file attachments.

The capacity of mobile technology to deliver synchronous communication and knowledge-sharing can provide benefits to human (or soft) systems. Evidence of these benefits can be seen in the assessment of m-technology projects and pilots. For example, Ragus (2004b) found that the project provided simultaneous personal development such as networking and socialisation outside of normal working groups. The KLIV project, a joint venture between the Malmö University Hospital and the Interactive Institute (Sweden) showed how short videos made by the staff and circulated in handheld computers supported peer-to-peer learning.⁹

The 'learning leads to learning' concept is more tenuous and it has received limited attention in m-learning research. However, the industry participants in Ragus' (2004a) New Practices in Flexible Learning Project found that the project had inspired new ideas for the incorporation of technology in the workplace, which indicates an enthusiasm for further learning that may not have occurred had they not been introduced to the m-learning opportunities.

Brodsky (2003) looks at other drivers of the learning organisation and concludes that, as a consequence of the adoption of technologies that allow customers to use self-service options, organisations will need to change the nature of their training programs. When routine transactions are managed through automated systems or online, customer service or sales staff need to handle the more complex transactions requiring a higher level of knowledge and interaction skills. Brodsky predicts that training technologies will become so smart and intuitive that technology will no longer be the focus, but will be replaced by the application and how it serves the needs of business.

Lundin and Magnusson (2003) see mobile technologies as a way of overcoming the fragmentation that results from a mobile workforce: 'within a distributed and mobile workforce opportunistic meetings with colleagues are naturally less likely to occur than

⁹ http://ict-consulting.se/viktor/pdf/KLIV_demo_29aug02.pdf

if workers are co-located' (citing Bellotti and Bly, 1996). At this level, mobile technologies address the problems of communication and mobility.

M-teaching: the experience and the future

Mobile learning has entered the education field only recently. While e-learning has been a feature of flexible learning for half a decade, m-learning is a relatively recent innovation, enabled through advances in operating system design, lower cost hardware, and the community acceptance of mobile phone technologies. This section of the report looks at current trends in m-learning, how m-learning fits in the pedagogical environment, issues for education and training providers, and future opportunities for m-learning. As with the *M-technologies in business* section, information has been sourced from the literature and web, and from interviews with education and training providers.

Jackson (2003) identifies three components of the technical evolution that will provide 'critical impetus' to the development of m-learning strategies

1. The ubiquitous availability of high bandwidth communications links (such as wireless and 3G networks) that will enable delivery of any item of learning material, anywhere.
2. The introduction of packet-based networks that provide an always-on environment, and will lead to the same low connection costs experienced in the fixed Internet environment.
3. An available base of low cost, full colour, multimedia mobile phone, PDA and PC devices to deliver and process learning tools and content.

While speed and priority of development of each component is difficult to predict, the direction of development is very clear. Greater bandwidth, low connection costs and multimedia will make m-learning a more attractive option, however Ragus (personal communication, 2005) reminds us that high tech materials are not always needed:

M-learning design falls into two categories: field-work, where the learner is experiencing the real-world situation and the prime purpose of the mobile resource is reference and assessment – in which case materials can be simple and effective; and classroom-based situations, which require animations and colour to inform and engage the learner. Both approaches should be based on sound instructional design principles.

Dacey (2005) expresses concerns about the challenges of materials development for m-learning. He reports that, until recently, it has been difficult to develop applications for mobile devices (although recent projects have demonstrated that this process is getting easier, and new versions of mobile operating systems are likely to simplify the process even further). Development difficulties have meant that educators first need to find an appropriate project specification, and then face the challenge of finding people who have the skills and willingness to develop the application for them.

Despite these challenges, early assessments indicate that both teachers and students respond favourably to handhelds (Ragus, personal communication, 2005; Roschelle, 2003) An exciting aspect of mobile technologies for education is that tools that first existed only on expensive desktop machines are now being made available on inexpensive handheld units (Soloway et al., 2001 cited in Roschelle, 2003).

Interviews with education and training providers identified that less than half of the providers engaged in discussions with students about the use of mobile technologies

for learning, despite the high level of use of mobile devices by students. Caryl Oliver (William Angliss TAFE) commented:

The topic that is becoming more frequent is how to get access to learning without coming into the classroom, and what mobile technology could be used to receive and store information.

Approximately half of the providers said that the use of mobile technologies for learning was a frequent topic of discussion with teaching staff. Some of their comments were:

- M-technology is being discussed more because the organisation is forcing it to become an issue.
- Change is happening, but the first task is to learn about and understand how to use the technologies.
- The most common discussion is about the development of mobile technologies within industry.

Providers were asked about student readiness for mobile technologies. The most ubiquitous mobile technology is the mobile telephone, so it was interesting to see what providers thought about student readiness for using mobile phones for learning:

- Mobile phones are mainly used to SMS parents regarding attendance and other communications.
- Some TAFE colleges already use mobile phones for communicating with students using text reminders.
- Students have mobile phones although PDAs are not as popular. Providers are less concerned with the device that students use, than with what they do with it.
- Resourceful teachers are incorporating SMS because young people are using it anyway, it's a great motivational tool.
- M-learning is ideally suited to adult education if it is used to extend the reach of programs. It allows students to get a response quickly, at all hours, they like the interactivity and the ability to receive a quicker response than they would via email.

A number of educators mentioned the issue of cost of mobile devices:

- Laptops enable students to dock into the student network, however these are not widely accepted because of cost.
- Students already have mobile phones and it would be good if they were used more for learning.
- More students would like laptops and wireless technology but there is a cost constraint in providing the equipment.
- If all students already owned laptops, PDAs or mobile phones it would be easier to use them for learning, but providers cannot ask students to buy them because the cost would exclude some people.
- SMS is already in place but the opportunities to use it for learning have not been considered in great depth – implementation will largely depend on practicalities and cost.
- Teachers would like to use PDAs and laptops, but the problem is resources to develop materials and provide support, the infrastructure is lacking.

How ready are students for mobile technologies other than mobile phones?

- Students are already using laptops but are looking for more wireless options.
- Students are ready for SMS and PDA to access learning objects and assessment pieces.
- In some organisations, PDAs are provided to students to do tests.

- Students are ready for greater use of 3G mobile phones and pocket PCs/organisers, which are already being used by students for communication because of their flexibility and portability.
- Students use laptops for general learning, mobile phones for downloads from the Internet and general learning, and a few who travel long distances use MP3 players to download lectures.
- On the other hand, one regional provider found that students were not ready for mobile technologies, but workplaces were ready.

Fannon (2004) reflected that young people do not experience geographical place and time as barriers. Although some older learners operate in a similar way, most use their phones as a tool to arrange face-to-face meetings to work on assignments or discuss a learning issue. Fannon's research also found only 12% of learners had the latest mobile technologies with Internet access and only 7% said they used MMS (multimedia messaging) for sending graphics or videos. Approximately half (55%) of the research group preferred to learn from books and use a bigger computer screen, on the other hand, almost half (45%) were comfortable with the thought of using Internet-enabled phones as the only tool for learning.

Teacher readiness for mobile learning is seen as a barrier by a number of providers:

- It all depends on the teachers and some have not yet mastered desktop technologies! The teachers are a critical part of this, and some are not ready. Only a small percentage of classroom teachers use PDAs and they are mainly for personal use, although some have used them as a teaching tool.
- A recent survey of teachers found that 2% had never turned on a PC, 5% could not burn to CD-ROM and there is no use of ICT for general teaching, although some ICT-based communications are done on an individual, personal basis.
- Not a lot of teachers use mobile technologies. PDAs are an executive tool, although mobile phones are ubiquitous.
- Mobile technologies are being developed for field work, primarily to communicate with the office.
- One organisation uses mobile phones to edit their newsletter.

Dale Spender (personal communication, 2005) was also concerned about the ability of teachers to understand and respond to digital learning opportunities, citing the aging teacher population and their lack of comfort with digital ICTs, the focus on 'teaching and memorising' as opposed to 'learning and seeking information', and reliance on 'doing it by the book'. This approach is fundamentally different to the approach of digital natives (Prensky's term for those born in the digital age: Prensky, 2001) for whom ICT is second nature, for whom 'not knowing is an impetus to find out', and who believe that 'if you need to use the manual, the product is no good!' On the other hand, there are some who believe that the non-use of manuals by digital natives simply reflects the lack of deep analytical skills in this group.

Spender's position is reinforced by Aquino's (n.d.) observation:

Teaching has a long established culture of individualism and secretiveness and many teachers are very challenged by the need to work collaboratively with technicians, web developers, instructional designers and programmers to deliver successful web-based education.

M-learning – is it different to e-learning?

Although the concept of e-learning is well known, relatively few organisations have successfully introduced an e-learning ethos. Peters and Lloyd (2003) found that many providers of online training are developing and managing their products based on traditional delivery paradigms. In order to be successful in the online environment, providers need to develop systems that allow them to be learning managers to facilitate and support a blend of delivery modes to suit the needs of employers and individual learners. In a market sense, Peters and Lloyd also found that the online training market is immature, with low sales and poor customer awareness. So where does m-learning fit? Is it a flow-on from e-learning, and thus will expansion of m-learning have to wait until the e-learning market is more mature? Or is m-learning a different market entirely, one that has the potential to eclipse e-learning?

Bowles and Nichani (2004) suggest that the e-learning market is changing and that emerging technologies are altering how the Internet operates as a medium for transferring information and knowledge. The authors see m-learning as a part of the e-learning market: 'the growth of satellite and mobile applications and other technology has had a profound impact on characterisations of e-learning' and cite the emergence of non-browser Internet technologies that support small-screen mobile devices as evidence of an expanding definition of e-learning.

On the other hand, Accredited Online Training (in an Austrade promotion: <http://www.austrade.gov.au/BusinessSearch/?cbsid=MELB326668>) refers to m-learning as a 'supplement' to e-learning courses, describing its use as 'downloading study sheets, revision and tests onto PDAs and mobile phones as an added tool for students to use while away from their PCs'.

Moehlert (commenting on Rheingold, 2004) asks 'since when has learning not been mobile?', and reminds us that learning is something you carry around in your head – it is not tied to place.

Perhaps the debate is best summed up by Attewell and Savill-Smith (2004):

Mobile e-learning is currently in its infancy. Although many experts in the field see great potential for the use of mobile devices in e-learning, there are presently very few successful implementations on which to base a study of best practice. Because of this, and the fact that some mobile devices are similar in functionality to conventional computers, it is only natural that the first generation of mobile e-learning content will closely resemble conventional e-learning, presented on a smaller screen.

As mobile devices evolve and people discover new ways in which the functionality of mobile devices can be applied to training, mobile e-learning will probably become increasingly different from conventional e-learning; no longer a miniaturised version of it.

The digital age has created a new relationship between teachers and learners. London School of Economics research found that children are the Internet experts in the family and described this situation as a 'lasting reversal of the generation gap' (The Guardian, 16 Oct 2003, cited by literacytrust.org, 2005a). This reflects the problems of digitally literate students in schools, where, rather than simply receiving and memorising the wisdom of their elders, which has been the tradition for millennia, students are now driven by their own information needs. Dale Spender (personal communication, 2005) observed:

Eight year olds think there's something wrong with their teachers. Don't they know that heads are unreliable places? That's what the save key is for. Even if you do store things in your head, you can't ever find it again.

Aquino (n.d.) reflects that learning is 'emotionally based and consistently and powerfully influenced by the learner's culture and experience' and that traditional teaching methodologies that are 'essentially passive, theoretical, text-based and linear' will fail to engage young learners and fail to deliver the skills needed for both social and work environments in the future.

M-learning in action

Despite the fact that handheld mobile devices have only recently had the capability to compete with laptops and notepad computers, there is only a small lag between mobile product development and trials with m-learning. From basic communications between teachers and students¹⁰ to modified online learning courses delivered on handhelds, pilot projects and m-learning implementation are occurring around the globe.

When Melbourne Law School relocated to a new purpose-built building at the start of 2002 a key feature of the design was the provision of pervasive networking. This allows students with mobile computing devices to access course material and conduct searches of legal databases within the classroom, which expands the depth of the discussion and the learning experience for the student (Hartnell-Young and Jones 2004).

PDA's are well suited to [educational] tasks. There are thousands of applications available (many of them free) that support a full spectrum of activities and academic disciplines. PDA's are also fiscally appealing to educational entities, with most models being much cheaper than desktop computers.
(Newton, 2004 in Ragus 2004a)

Collaboration between schools in Greece and Spain was tested via the MoTFAL project. Students from Spain took digital camera-enabled PDA's into archaeological sites. Greek students SMS'd requests for information and photos to the Spanish students who would then respond. This process was then completed in reverse, with the Greek students sharing their archaeological sites with the Spanish students. The main advantage was the level of collaboration between the students, with both parties asking and answering questions they may not otherwise have thought of. The appeal of interactive media (compared to a text book) and the ability to provide some context by observing people in locations were key success elements in the project (Geddes, 2004).

eHealth training for Pharmacists

The Pharmaceutical Society of Australia has organised Information Technology, eHealth and PDA's training for pharmacists around Victoria. The eCommerce resources are being supplied by Multimedia Victoria, and information on using mobile devices for health has been brought together from a range of Australian, US and European sources.

<http://www.aspinonlineconsulting.com.au/News.htm#mlearning>

Medicine is applying mobile technology to support remote learning in rural health education, and facilitating reflective practice. Hartnell-Young and Jones (2004), describe the use of Tablet PCs to help students to capture and store confidential patient information and deliver just-in-time information on clinical problems. In addition, students kept a journal of their activities as a reference for follow-up discussions with their instructors.

¹⁰ TAFE NSW Open Training Education Network recently surveyed students about SMS communication with teachers, and within one hour 11,000 students had replied that they would be very happy with this form of communication (Collareda, 2004).

In the UK, students are playing an environmental detective game facilitated by mobile devices. Students play the role of environmental engineers who are presented with a scenario in which the spread of a toxin is simulated on a location-aware Pocket PC equipped with a GPS device. The Pocket PC also allows students to investigate the toxic spill through sampling chemical concentrations in the groundwater.
(http://www.pjb.co.uk/m-learning/interesting_research.htm)

Zurita and Nussbaum (2004) have demonstrated the effectiveness of handheld devices in teaching first-grade children to construct words from syllables. In a month-long controlled experiment, children who were supported with technology were observed to have significantly higher word construction test score improvements than children who were using the paper-based activity.

History teachers have used GPS enabled Tablet PCs to bring Los Angeles History to life. The GPS tracks the location to determine how the story unfolds (Knowlton, Spellmand and Hight, n.d.).

Education and training providers interviewed for this research reported that the availability of m-technologies presented opportunities for new types of delivery and management of learning. They reported that m-technologies:

- Make teachers think - the thought process is often hard to change and using new technologies seems to help.
- Overcome geographic barriers, m-learning removes the problem of locality and the requirement that students travel to access learning.
- Offer greater flexibility for staff and students.
- Allow learners to learn in the field, where and when they want. However, mobile phones are not a huge teaching tool, as the students use them mainly for social contact and do not want to use their mobile phones as a learning tool.
- Force providers to rethink the way that they 'teach' learning: We need to break down the elements of the course into small packages based on mobile technology so that students can access portable learning, learning activities, and multiple choice games from their mobile units.
- Provide a faster way of informing students (using SMS) and flexible delivery that is not bound to computer – we can engage across physical space.
- Enable situated learning or learning in context, using phones with cameras/video capabilities to enable students to capture their own material and instantaneously transfer to other students and lecturers. Mobile phones are also used as tools for group learning.

Much is made of the potential of m-learning, but what are its limitations? Leo Gaggl (Bright Cookie) reflects that:

As an add-on to other modes of deliver, m-learning will increase. But it won't replace other forms of e-education because screens are too small and hard to read, and if you make them bigger, the device isn't as mobile. M-learning is most useful when it's in a mobile, field environment (2005, personal communication).

34 North 118 West

Imagine walking through the city and triggering moments in time. Imagine wandering through a space inhabited with the sonic ghosts of another era. Like ether, the air around you pulses with spirits, voices, and sounds. Streets, buildings, and hidden fragments tell a story.

The setting is the Freight Depot in downtown Los Angeles. At the turn of the century Railroads were synonymous with power, speed and modernization. Telegraphs and Railroads were our first cross-country infrastructures, preceding the Internet. From the history and myth of the Railroad to the present day, sounds and voices drift in and out as you walk.

(Knowlton, Spellman and Hight, n.d)

Pedagogy?

M-learning enables learning opportunities that are significantly different to those provided by e-learning (at a desktop) or paper-based distance learning.

As discussed under the earlier heading *Drivers of m-learning in business*, m-learning is highly suited to a constructivist approach. A constructivist learning environment allows students to build their own knowledge (based on previous knowledge) while working jointly and reflectively with their peers and teachers. M-technology can support constructivism and collaboration to achieve creation of new knowledge (Zurita and Nussbaum, 2004).

Social constructivism, and its corollaries in situative theory and communities of practice suggest that learning should be constructive, collaborative, interactive, and contextualised rather than the didactic transmissive modes of instruction based on a teacher-centred pedagogy found in more traditional classroom methods (Rochelle et al., 2000).

Roschelle (2003) also observed that mobile devices become part of a complex network of communication that can occur in the same physical space in which students and teachers participate socially in teaching and learning. Two distinct kinds of participation are occurring at the same time and in the same space: the normal social participation in classroom discussion and the new 'informatic' participation among connected devices.

Fannon's 2004 interviews with students shows the complex ways in which mobile communications are used to support group or project work:

Amy: Um....we email....even though we work together a lot, we email and say, "Can we meet?" We either text message or we email. Depends whether we're online or not. And we often distribute information by email – that everyone gets the minutes, gets the agenda or if someone's worked on a certain part of the project, we email and say, "Can we look at this and what do you think?" ...we also use it to just often just to send each other interesting pieces of information ...stuff that might relate to the course.

Tim: For me because I've only got dialup, I use my mobile either to ring or to text someone who I can't get through email or ICQ. Once I'm on the Internet, it's free so I'll use that for the majority of it but if I need some help online, and the other person's not online, I'll ring and get them to tell me what I'm doing, over the phone, while I'm online. If I had more bandwidth, I wouldn't need to use the mobile at all. I'd just ring and be online at the same time (Fannon, 2004).

These excerpts demonstrate how m-learners can see their peers as teachers, and how m-technologies enable learning to occur outside of traditional learning spaces.

M-learning can therefore introduce new elements for teachers. Chen et al (2002, in Bridgland and Blanchard n.d.) describe the principal pedagogical considerations to be taken into account with m-learning as:

- the urgency of the learning need
- the need for knowledge acquisition
- the mobility of the learning setting
- the interactivity of the learning process
- the situatedness of the instructional activities
- the integration of instructional content.

What is the approach used by educators in Australia? The research interviews gave an insight into the level of focus on the structure of learning. Education and training providers were asked about learning outcomes, their responses (see below) show that they understand the pedagogical opportunities provided by m-learning, which is seen to:

- Help to break down the financial and mobility constraints of learning.
- Improve literacy through collection and provision of evidence for assessment portfolios.
- Enable the use of digital story-telling to demonstrate competence.
- Provide faster, more exciting ways of teaching, more flexibility, more mobility.
- Allow for full qualifications to be delivered via mobile devices.

In many organisations, m-learning is yet to be structured into the curriculum:

- The uptake of m-learning depends on the teacher and the curriculum coordinator.
- It is experimental at moment, providers are looking at all ways to deliver subjects, so that students can choose how they would like to learn.
- The education of teachers about the use of mobile learning devices needs to come first. Teachers need to understand the benefits of letting students use devices for learning. At this stage, teachers are still very negative about students using mobile phones in the classroom other than for contacting parents at home time.
- M-learning needs to fit within a whole matrix of curriculum and assessment, the positioning of this mode of delivery needs to be thought through before it is implemented.
- Some organisations consider the uptake of the technology at the work place as the prime driver of m-learning.
- One organisation stated that they are just starting to look at mobile technologies, which are regarded as a new area within e-learning.

Only two respondents said that m-learning was already in place in their organisations, and both were delivering learning to remote communities:

- M-learning is not structured into courses, but students would experience it in most subjects.
- M-learning is structured into remote teaching so that all students have access to learning without having to come into campus. This provider also commented on the financial savings from not having to provide physical space for all students. However issues such as whether m-learning allows higher quotas for courses and how to structure lecturers' pay are still to be resolved.

The literature and web search provided other insights into the structure and outcomes of learning. In one of the better-known m-learning trials, the M-Learning Project, mobile devices were lent to learners in three countries, and their use assessed (Attewell, 2005, p10). Learners had access to project systems and materials via a microportal that points to:

- learning materials
- mini web page builder tools
- a collaborative activities tool (the mediaBoard)
- peer-to-peer communication services (messages, chat, discussion and blogs)
- the learning management system
- simple help guides for the system
- links to places on the web that may be helpful or interesting for the target audience (e.g. alcohol, drugs and sexual health advice services, job hunting and online learning services and dictionaries).

The microportal also managed integration and security. Analysis of the evidence collected during the research suggests that the use of mobile learning may make a positive contribution in the following areas:

- **Mobile learning helps learners to improve their literacy and numeracy skills and to recognise their existing abilities.** Improvements were reported in learners' reading, writing and maths skills. Most improvements were noted amongst those learners initially described as being 'less able' or having 'very limited ability'.
- **Mobile learning can be used to encourage both independent and collaborative learning experiences.** Many learners enjoyed the opportunity to use the mobile devices to learn independently of a group setting. Others welcomed the opportunity to work collaboratively.
- **Mobile learning helps to remove some of the formality from the learning experience and engages reluctant learners.** This aspect of traditional learning can often be the most frightening for those who have not previously engaged with learning, however most of the learners in this group were familiar with games machines such as PlayStations or GameBoys, and were quick to respond to mobile devices.
- **Mobile learning helps learners to remain more focused for longer periods.** It is possible that this effect was due to the novelty of using mobile devices and it is not clear whether the focus would be retained over time.
- **Mobile learning helps to raise self-esteem.** Loaning equipment to young adults to use in their personal environments has resulted in other benefits not directly related to the learning experience. Some learners were surprised and proud to be trusted with such expensive and sophisticated technology. Another boost to some learners' self-esteem came when they realised that as experienced users of mobile phones they possessed useful skills which others perceived as important. Some of these learners became ad-hoc mentors to their peers and gained further self-esteem as a result.
- **Mobile learning helps to raise self-confidence.** There were changes in learners' level of general self-confidence. This was not specifically linked to the development of their confidence in using ICT or their confidence in the areas of numeracy and literacy, but linked to self-esteem.
- **Mobile learning helps learners to identify areas where they need assistance and support.**
- **Mobile learning helps to combat resistance to the use of ICT and can help bridge the gap between mobile phone literacy and ICT literacy.**

(Attewell, 2005, pp13-14)

Klopfer (et al., 2004) consider that mobile devices could make a significant contribution to classroom practices because of their ability to 'integrate playful behaviour that engages students in authentic explorations into a collaborative learning environment'. This usage extends beyond the classroom because mobile technology also enables dynamic communications and participatory simulations when people are separated by distance. M-learning releases students from being bounded by classroom walls, geography and schedules that do not suit their work and study patterns – students are able to study in their own time and in their own space.

Assessment is expected to become a key use for mobile technologies in learning environments. Handhelds can be used to do on-site assessment and the inclusion of cameras to capture images can provide evidence of competence or learning. Mobile technologies are ideal for formative assessment, in that they can provide feedback to both the instructor and the learner and hence allow modification of future learning activities according to the feedback received.

Mobile or electronic learning are simply a mode or vehicle for learning, albeit one with the capacity to locate learning in situ, which provides some advantages. Whatever the mode used to support learning, in order to be effective, the delivery must be well designed and facilitated.

Challenges

As with any new opportunity, there are challenges to be faced. The challenges for m-learning include: a change of mindset from teaching to enabling; staff and students having skill and confidence in the technology; and the need to develop ICT capacity that supports the technology.

Perhaps the biggest challenge, identified by Rheingold (2004) is the capacity of education providers to understand and adapt to the new social systems that are enabled by mobile communications. He cites the examples of 'nomadic swarms' of university students who do not receive instruction on how to use mobile communications to augment class discussion, or conduct concurrent search or group note-taking during a lecture. 'In the absence of instruction in IT etiquette, students SMS, chat, game and find their own way through the pedagogical cyberscape while lecturers try to cope.' Rheingold asks: 'Are we ready to sense which of our students arrive at our campuses with such experiences already under their belts? How do nomadic swarms work with our anthropologically sedentary campuses?'

The challenges facing teachers of 'connected' learners can occur both in and outside of the classroom. Alexander (2003) observes that the most controversial instance of m-learning occurs in the traditional classroom, when students gain access to wireless connectivity. 'Some professors report frustration at students' wandering attention, as instant messages become more attractive than a lecture. Others turn to technologies that beam students' desktops to a projector, using the threat of embarrassment as attention enforcement.'

Whether the behaviours of the wired generations will lead to wide-scale change in education systems that have grown out of a 'traditional transmission' pedagogical approach remains to be seen. However, some teachers have already identified 'insertion points' for mobile technologies that allow them to create innovative teaching approaches such as beaming content to students, or using 'clicker' applications in lectures (Bridgland and Blanchard n.d.).

The m-learning fraternity have the benefit of the e-learning experience. Whether learners find m-learning more intuitive and usable than e-learning, and therefore create different demand conditions, remains to be seen. In their 2003 study of demand for e-learning with vocational education and training students, Peters and Lloyd found that:

- Employers were unlikely to provide computer equipment for study purposes.
- Online students complained about the problems created by low student response to the compulsory chat or bulletin board elements of their courses.
- One in four online students was not satisfied with their online course and younger students, because of their increased need for support and socially situated learning, had the highest dissatisfaction ratings.
- Rural and remote customers were restricted in their access to web-based applications because of the high cost and low bandwidth of Internet access. Rural students need to study in social settings and therefore technologies that promote isolated work were less attractive.

Students equipped with mobile and wireless devices are reshaping the classroom environment. Spaces structured by static rows of computer desks, with screens or bulky monitors blocking views, are increasingly obsolete. Instead students can sit where they like, depending on the instructor's flexibility. A class can change quickly from a lecture to a small group discussion or lab format, while retaining the full powers of computer-mediated communication.

Instructors project notes on a wall, talking through a sequence of points, then break the class up to pursue team projects or discussions. Learners quickly arrange themselves in ways conducive to their comfortable conversation and writing, rather than following the dictates of pre-arranged furniture (which is often hostile to the best learning).

(Alexander, 2003)

Unless the quality gaps that are evident in e-learning provision are addressed during the development of m-learning, the opportunities of mobile technologies as a learning tool will be limited.

Bridgland and Blanchard (n.d.) reflect that cases of successful integration of mobile technologies into e-learning share a common factor – planned support for the innovation in the form of technical expertise, help services and training to support both students and teachers. For students to receive the most beneficial instruction, teachers and instructors need to be highly proficient in the use of the technology, with ongoing training and professional development to motivate a positive view of technology. Technical support within the institution is essential.

Nokia (interview 2005) reflected that the educational market is too small for products to be designed specifically for that market. Palm (interview, 2005) reported that many third party developers are producing hardware and software for the education market.

Design Directions for m-learning:		Keegan, 2002
<p><i>Increase</i></p> <ul style="list-style-type: none"> • Speed • Bandwidth • Memory • Ease of use • Durability • Input/output quality 	<p><i>Decrease</i></p> <ul style="list-style-type: none"> • Size • Weight • Power demands • Maintenance • Price 	<p><i>Educationally-sound learning</i></p> <ul style="list-style-type: none"> • Interactive • Authentic • Collaborative • User-centred • Media rich

Although costs are reducing, the present cost of providing and supporting m-learning has restricted uptake, especially for small providers. However, the cost of wireless will continue to fall as a result of increased consumer demand as well as competition within the telecommunications market, and the influences will make the technology more accessible (Bowles, cited by Ragus, 2005).

The future

E-learning experts (Rheingold, 2005a) are predicting that the use of mobile technology as a part of training will, within the next five years, be one of the most recognisable components of e-learning. Examples of how m-learning has already been implemented have been collected from the web:

- Some American colleges are giving students a free mobile phone with unlimited local and inbound time and good rates on long distance calls. These phones are programmed with some buttons preset to access services and student groups and students can push a button to get college security, to reach their roommates and even to deal with a team that is working on a class project (Maisie, 2003).
- Richard Anderson, a professor in the Department of Computer Science and Engineering at the University of Washington, says the campus of tomorrow will still be recognisable because a big part of education involves instructor and student discussion and interaction – most of it taking place verbally.

According to Anderson, the key m-learning opportunity is the integration of electronic presentations with student devices. 'The instructor presents slides and writes on slides, but students have laptops or tablets or other machines receiving the slides and the digital ink in real time. They get the materials as they're presented and do their own annotations.' Student annotations can be submitted back to the instructors allowing the instructor to pose a classroom exercise on the slide and then have the students do the exercises and send the results back. In turn, the instructor can quickly go through the responses and select some of them to display on the screen anonymously (Schaffhouser, citing Anderson, 2005).

- Villano (n.d.) wrote about a college m-learning program in which the lecturer wanted to build his class around handheld solutions. By using low-end AUD\$250 handheld devices (the college donated AUD\$50) and eliminating text books, the cost of the equipment was comparable with the cost of other courses. The PDAs were integrated into the class in a variety of ways:
 - ♦ Connected to a projector to teach interactive lessons.
 - ♦ Student-created blogs formatted for their devices.
 - ♦ Instruction in Microsoft Pocket Excel and programming Visual Basic.Net for Mobile Applications allowed students to create their own materials.
 - ♦ Surveys were done in the community, then responses recorded directly onto handhelds.

'It sounds silly, but the handheld really did change the entire nature of this course. Using a handheld allowed me to give assignments that would allow students to bring things together in a much different way' (Frydenberg, in Villano, n.d.).

M-learning opportunities

- Portability (learning anytime/anywhere)
- Location (real time connection between site and workplace)
- Wearability (expert in your pocket)
- Networked communication (coached collaborative learning)
- Personalisation (photo, audio, SMS)
- Blended learning (+ classroom, e-learning)

Keegan (2002)

M-learners: the consumer as a learner

In the education sector, the learner is the consumer of the 'teaching' product. The customer (the person or organisation that buys the education), is typically not the consumer. In reality, the industry organisation is often a partner in course design, but employees of industry partners are still the consumers of the product.

Why separate customer and consumer? Because in today's education and training environment, learners regard themselves as consumers. As Peters and Lloyd (2003) observed:

Students are bringing consumer attitudes to education, seeking convenience, service, high quality and low cost, they will not pay for activities, services and buildings they will not use.

This section of the report examines what it means to have consumers buying learning products. What can we expect from the m-learning consumer?

The setting

Perhaps the single greatest indicator that m-learning may be different to e-learning is the level of ownership of a central m-learning tool, the mobile phone. The table shows mobile phone ownership in Australia, compared to the USA and Canada.

Country	Age Group	Millions in Population	Percentage owning a mobile phone
Australia	15-19	1.33	65%
	20-24	1.31	88%
USA	15-19	19.92	40%
	20-24	19.12	61%
Canada	15-19	2.07	52%
	20-24	2.06	60%

(MLearn 2003 Conference)

The astounding finding is that 88% of Australians in the 20-24 age group (in 2003) owned a mobile phone. Although a good percentage of these would be low-end devices that are not capable of email or web access, the predicted reduction in price for smart phones and phone-enabled PDAs will make m-learning devices available to a majority of young people.

McCordle predicts that in the next 10 years, 60% of the population will choose to work flexibly, working in their own way, in their 'own time, and in a way that suits their lifestyle' (in Ragus, 2004a). If this prediction for flexible work patterns eventuates, what might be the demand for training that can be done 'on the move'?

Giving Gen Ys and Millennials the training they want is not as simple as making some parts of standard courses available in small chunks to be read on handhelds. As Eklund (2003) observed, learner-centred learning is replacing instructor-centred learning, and learner-centred learning is initiated in homes, offices, shops and factories as well as classrooms. Learning on the move, in small chunks, following interest rather than structured thought processes does not necessarily deliver deep thinkers. While making learning available from mobile devices might meet the demands of the marketplace, will it provide knowledgeable leaders of the future?

To make sense of the new forms of delivery, courses will need to be restructured and institutions will have to come to terms with what it is that makes a course. Are courses something that students enrol in at the beginning and do in a structured way until completed? Or are qualifications reached when students have done (or proven their capability in) all elements? The management of these two approaches is very different, and the relevance of (and demand for) some courses will be lost if students cannot gain accreditation for the learning they have done. Ragus (2004a) noted that today's students tend to move in and out of education, work and employment. Tracking the learning experience of these students will be an important part of determining whether they have achieved the requirements for qualification.

Making life-long-learning accessible is essential to maintaining Australia's competitive position in the global economy. Sharples (2000) saw links between philosophy of life-long-learning and the delivery potential of new technologies (see box).

Life-long-learning	New technology
Individualised	Personal
Learner-centred	User-centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

(Sharples, 2000)

the

The 'always on' generation

Known as the 'always on' generation because they are never far from an ICT device that is connected and communicating, this group is 'immersed in cyberculture and is untethered, mobile and wirelessly connected' (Alexander, 2003). As a result, both educational space and learning time are changing:

The traditional class works on a two-step information access schedule, alternating between an isolated classroom and an out-of-class connection to the full world of information via libraries and the Internet. Always-on connectivity allows learners to blur those two modes, hitting the Internet on demand or in mid-discussion, texting classmates and instructors at any time (Alexander, 2003).

Bridgeland and Blanchard (n.d.) observe that in universities, the current generation of learners operates in an 'always on' environment. 'They are digitally literate, mobile and experiential and gravitate towards group activity' and the 'largest discretionary block of time for students is outside of class.' Olinger (2004 in Bridgeland and Blanchard) says that informal learning is self-directed, internally motivated and unconstrained by time, place or formal structures. The always on generation are perfectly positioned to access informal learning.

Choice has gone mainstream with this generation. They are unlikely to play by the learning rules set by earlier generations because they have ways around them that are more effective and more immediate.

Smart Mobs and Swarms

One of the characteristics of the 'always on' generation is their swarming or tribal behaviour. ICT-enabled communications are not restricted by geography or family affiliation, communities are now 'communities of interest' which can form and disband as needed. Smart mobs emerge when communication and computing technologies amplify human talents for cooperation (Rheingold, n.d.).

Texting is replacing speech for much communication among young people. It is immediate, accessible, private and gives them unprecedented control over how they communicate with friends and family. 'It is not just about communicating but displaying to those around you that you are popular, successful and have a large social network.' (Telegraph, 20 December 2004 in literacytrust.org 2005b)

Mobile devices can help to build social networks, smart mobs and other forms of mobile community. Axup (in Rheingold, 2005a) has studied the travel blogs of backpackers and found that

backpackers move in flocking patterns up and down the east coast of Australia, and they gossip as they go. They form ad-hoc groups for short periods, and memes [ideas] migrate between subgroups. Increasingly, mobile communication devices are speeding up these migrations. Groups travelling together sometimes share one phone, often swapping SIM cards. Camera phones and digital cameras with LCD screens are used to show one another what campsites and landmarks look like. Blogs keep family and friends informed.

Swarm behaviour is not necessarily something new, after all, getting together for common purpose is a core human trait. The introduction of mobile ICT has simply changed the way swarms form and communicate. Alexander (2003) believes that universities are good examples of swarm learning that have been working well for hundreds of years. He reflects that a classic purpose of a university is the co-location of experts, students, and information. 'This suggests swarm behaviour, where multiple members of a distributed group coalesce on a single point. M-learning can amplify this model, if interested persons can contact and hook up with experts and co-learners nearby and around the world, gaining access to digital and physical content.'

The ubiquitous [mobile] environment enables educational swarming at a planetary level.
(Alexander, 2003)

Swarming is more than just communication, it is being part of a group. Mobile phones have become an integral part of group behaviour. Goggin (citing Hjorth, 2005) reflects: 'Twenty years ago at a concert, fans would have held up lighters. Now they hold up camera phones. They can check out the photo or video when they get home because, after all, the experience has to be mediated – that's how you know it's real.' Swinburne University's Dr Belinda Barnet points out that the mobile phone is more important than just providing accessible communication 'if you lose your mobile phone you lose the catalogue of your experiences – it's like a personal diary' (Goggin, 2005).

Who is missing out?

It is possible to be swept up in the hype surrounding mobile technologies and the m-learning environment. However, as in all change, there are winners and losers. Who is losing in the m-world?

A read through the entries on m-learning blogs shows some interesting perspectives. Learners come from different backgrounds, and not all have easy access to the world of mobile technologies. Gaborpor (a student in an American college - in Rheingold, 2004) found that in auditoriums of 400-600 people, he is one of a handful with a laptop, he has not seen a single PDA used in a classroom and mobile phones are only used for SMS and games. Gaborpor also reminds us that some groups of students will remain outside the flock, no matter how easy the tools are to use.

In preparing for the inevitable expansion of m-learning, it is important that we do not assume that the audience is confined to young people. While much of the focus of this report has discussed young people because they have been quick to change their behaviour as a result of mobile technologies, the age of students in higher education in Australia is rising. Peters and Lloyd (2003) found that online students were significantly older than students who studied in the classroom or using traditional distance education methods. These older students tended to be studying for work-related purposes and valued the flexibility that online delivery could provide. It is likely that this group also have the financial and technological capacity to use PDAs and smart phones as learning tools. Learners with limited experience of online or mobile technologies may find the medium challenging, and support needs to be available to ensure that these groups are not excluded.

So, will m-learning cater for the needs of learners with disability, or learners from disadvantaged backgrounds who may not have the experience or funds to enable access to mobile technologies?

The experience of Ison et al. (2004) who trialled SMS with disadvantaged young people as part of a New Practices in Flexible Learning Project, indicates that disadvantage and lack of ICT experience is not necessarily a barrier for m-learning. The project team found that SMS messaging was highly motivational and supportive of content delivery. Once again, the project confirmed the need for a constructivist approach evidenced by the enthusiasm of learners to be involved in the creation of curriculum and learning strategies. Thus training on how to learn, and how to use the technology, increases the benefits of the learning experience, good practice that should be applied to any group, but particularly those with limited experience in self-directed learning or the technologies that underpin delivery and collaboration.

There are those who say that the coming of the information age, with its computers, mobile phones, palm-tops, swipe cards and Web networks presents Aboriginal peoples and Torres Strait Islanders with major threats of exploitation, disempowerment and assimilation into a developing global culture -- that we could end up being the information poor in a world of digital haves and have-nots.

While there is no doubt this threat is real, it is a view that paints only part of the picture. These technologies also present us, as Aboriginal peoples and Torres Strait Islanders, with enormous opportunities and the potential to effect real change in our lives. Information technology offers us new and exciting ways to conduct our business and allows the development of alternate strategies to address many of the inequities that our peoples confront.

Page and Katitjin (2000)

Educators who were interviewed as part of the research for this report reinforced that the take-up of mobile devices for learning is still very much in the 'trial' phase. However, the delay in introducing m-learning was attributed to a lack of institutional capacity to develop materials and provide ICT support rather than reluctance of learners.

Access issues have been an on-going topic of debate in e-learning, where the cost of desktop computers and the availability of adequate bandwidth have been barriers for disadvantaged, Indigenous and rural learners. Mobile devices are generally cheaper than desktop or laptop computers, and better bandwidth and Internet access in rural and remote areas are expected to contribute to better access to m-learning.

What does this research tell us?

The interviews with education and training providers provided some insights about m-learners. Educators considered that all students were able to use m-technologies to communicate with each other, and most could use it to communicate with their teachers, although there were some groups who were more likely to use m-technologies:

- Those that find it harder to get to the uni, those in workplace training, or remote areas and those who want to download from PDAs or mobile phones and not come into the classroom.
- Indigenous students, and those who do not like writing.
- Those born after 1980.
- Rural and remote students.
- Students who are already using SMS.
- Younger adults who work in industries where there is a high level of IT dependency.

There was a wide range of responses to a question about which students are most likely to use m-technology to do research and gather information:

- Those with mobile phones and laptop, which is most students.
- Those who could afford to do so off campus (where technology is not available free of charge).
- Those who are accessing web sites that are scalable for PDAs and 3G phones (otherwise searching could become tedious and time consuming).
- Rural and remote students.
- Study groups, both within schoolyards using wireless, and outside for those who have their own mobiles and laptops.
- Those who are working together on research projects.
- Under 30's who are involved in the IT sector.
- Those who like it will do so for learning as well as general purposes.

Students most likely to 'timeshift' lectures and lessons were thought to be:

- Those who use it to make more use of their time, especially their leisure time (a growing percentage of students).
- Students with early morning lectures, who work part time or those in the workplace.
- Any with home or work constraints and who knew how to use the technology for that purpose.
- One respondent thought that all students would timeshift if it was made available to them.

Educators thought that the students who were likely to use m-technologies to support group learning and collaborative projects were:

- Those supported or inspired by good quality teaching.

- Study and project groups, particularly students who can engage from home or use their own laptops.
- Those who enjoy using m-technologies for purposes other than learning.
- Students with project work in the field.
- Those who travel distances to work with study groups.
- Those directed to do so, although students tend to set up informal networks automatically, and are more collaborative than society used to be.

Only one educator reported that students were permitted to use m-technologies in the classroom, although there were greater levels of acceptance of its use in libraries and a general acceptance of use around campus. All educators believed that their students were likely to use mobile technologies on public transport and at home. Students also used mobile technologies in Internet cafes and workplaces. The favoured technologies were mobile phones (small, fast, efficient and flexible).

Less than half thought students used laptops, mainly because of the cost constraints. Only two educators thought their students used PDAs. Students, parents, peers and employers all had an equal say in the decision to purchase m-technologies. A small number of providers required that students provide their own mobile devices as a requirement of their course.

On the other hand, teachers and lecturers liked to use laptops more than mobile phones. They liked digital projectors (which are not included as a mobile technology in this report because they are not a communication or information storage/access device) and PDAs (for personal use). The difference in device between teacher and student is marked and reinforces the concerns expressed earlier in this report about the lack teacher preparedness for the digital world.

Mmmm, where to from here?

The main drivers of m-technologies and m-learning are social, technological and global. The strength of these drivers lies in their effect – all are highly influential in their own right, but as a combination they herald new work and social patterns that demand the attention of education and training providers.

Mobile work and mobile careers reinforce the need for continual learning. Because of the pressure to acquire new knowledge, learners no longer have the luxury of memorising content or setting aside long periods of time to complete courses. Increasingly, learners are demanding learning that is applicable to the situation at hand. Educators are rightly concerned that this type of learning can be superficial, and may affect learners' ability to undertake sustained research or to deliberate complex issues. The challenge to educators is to create m-learning systems that develop deep knowledge.

Mobile learning will become an essential element in new economy, because of its capacity to access rich information, tap into highly efficient communications, and support data transfer and storage – factors that underpin contemporary knowledge management strategies.

Linked global communications have brought choice to individuals. No longer constrained by physical location, learners can construct their own learning from online information sources, undertake specific learning required by their employers, or make a selection from a range of education and training providers. When consumers have this range of choice, providers need to respond; to adapt to the new environment or risk failure. The emerging education and training environment is not simply technological. The provision of information on demand via the Internet, and the filtering function provided by search engines, has improved learners' skills in searching for and evaluating new information. In this way, all Internet users are learners accustomed to assessing information and constructing their own new learning. The tolerance of consumers for a traditional pedagogical approach is fast disappearing.

Fortunately, technology is still catching up with latent demand. Devices that seamlessly integrate telephone, email, web, and personal data on standardised operating systems are still emerging and are relatively expensive. However over the next two to three years, technological advancements are expected to make fully integrated micro-ICT devices a reality, and as soon as this happens, the price will begin to drop. If the uptake of mobile phones gives any indication, within a decade a significant proportion of the population will be 'always on' using wireless ICT devices with full desktop capability. The combination of flexible work arrangements, increased pressure to maintain knowledge-based skills and extensive choice of training provider is expected to create increased demand for learning that can be acquired 'in my time, and in my space'.

Perhaps we are beginning to see the emergence of learning swarms. We already know the precursors, in the form of interested learners who appear at campus libraries and museums, driven by an experience that excited them, such as a film, a book, or a conversation.

Now the socialising powers of mobility and wirelessness could expand this drive into collaboration. An interested learner could ping a network or site for learning engagement: digital objects, digitally tagged materials, learning objects, instructors, other learners and instigators.

(Alexander, in Rheingold, 2004)

Appendix A: Mobile Technologies for Learning

This section provides an overview of mobile technologies that have the potential to be used for e-learning. This information has been sourced from product advertisements, industry and sector websites and Wikipedia: *The Free Encyclopedia*.

CD-ROM

Intended use

Recording, storage and play-back of electronic data in a format that can be used with CD-ROM (Compact Disk with Read Only Memory – as distinct from audio CDs) In the early days of limited bandwidth, CD-ROMs were an essential component of e-learning. As access to good bandwidth becomes more prevalent, the dependence on CD-ROMs is reducing. Areas of poor bandwidth (such as many rural and remote regions) will continue to require e-learning materials on CD-ROM.

Actual use

CD-ROM will continue to be the main storage and transfer facility for large files in the short term. Increasing access to broadband and the popularity of flash and mini hard drive devices are reducing the use of CD-ROM for transfer and storage of small files. MP3 players are usurping the mobile audio market, and DVD technology is expected to increase in its share of the portable video market.

Potential

Both technologies will probably be superseded by web-based videocasting and digital television in areas of good bandwidth or broadcast reception. CD-ROM will continue to be needed in other areas and for storage of large file formats.

Convergence

Limited.

DVD

Intended use

Recording, storage and play-back of video, sound and data, storage of large files or quantities of information. DVDs are a popular platform for video games and applications that require multiple audio tracks because of their capacity to hold more than one channel of audio that matches the video track. This makes them ideal for multi-lingual applications.

Actual use

The availability of DVD Recorders and portable DVD players provides opportunities for m-learning with some capacity for interactivity.

Read/write DVD technology is only just becoming widely available to the market. Its use appears to be largely restricted to copying of existing DVD files.

Potential

How writable DVD applications will evolve in the consumer or e-learning markets is yet to be seen, however the longevity of the medium is under some doubt because of anticipated developments in web-based videocasting and digital television.

Convergence

Limited, although the availability of portable DVD players and recorders may create new opportunities.

Flash storage devices/drives

Intended use

To store and transfer files using flash memory via USB connections. Flash drives that have no other functionality than file storage usually derive their power from the computer USB connection and are therefore not able to be used unless plugged into a computer.

Actual use

In their basic form, flash drives are growing in popularity for file storage and transfer facility.

Flash technology is also used in place of hard disks in small storage MP3 players (up to 1 gigabyte) because it is less sensitive to vibration than hard drives. This makes it suitable for situations where equipment needs to function well under bumpy conditions, which include sport or vehicle-based players on bumpy roads (such as outback and remote areas).

Potential

Flash technology is expanding rapidly in the marketplace. Increased storage capacity will provide an 'all terrain' platform for new and emerging applications.

Convergence

Flash is a highly convergent technology, particularly for MP3 audio and file transfer applications.

Global positioning systems

Intended use

To provide real-time electronic latitude and longitude positioning. Initially produced for military and commercial navigation markets, GPS technologies are becoming smaller, cheaper and more accessible. The agricultural industry has adopted GPS in computer-controlled seeding, tilling and harvesting equipment, and the transport and logistics sector uses GPS to track and monitor vehicle operations. The inclusion of GPS in some passenger vehicles has spread their use beyond sports and commercial applications. Devices to aid navigation for people who are visually impaired are now available.

Actual use

While still primarily a tool for geographic location, other applications for GPS technologies are being tested in recreational, research and commercial fields.

Potential

GPS has potential for situations where real-time feedback about mobility can contribute to the learning. The transport and logistics sector are making strong investment in this technology.

Convergence

GPS capability is already being bundled with some hand-held devices, and data sets for major Australian cities suited for use on PDA/GPS devices are available.

Laptop/notebook computers

Intended use

Fully functioning personal computers that are portable, can be email and web enabled through data cables or wireless transmission.

Actual use

The ability to have full PC functionality in a light-weight package means that laptops are still the preferred device for portable PC-based applications although their relatively high price can be inhibitive for non-waged students.

Potential

Continual size and weight reductions are likely to keep the laptop as a popular mobile platform and the spread of wireless web access may increase the use of laptops in mobile e-learning, particularly for learners who want larger sized screens and keyboards that are easy to use.

Convergence

Software convergence is occurring at a faster rate than hardware in laptop/PC design. The expansion of Voice over Internet Protocol (VoIP) means that laptops (and other mobile computers) can provide low cost real-time voice communication.

Mobile computers

Intended use

Although there is no widely-acknowledged definition of mobile computers, the use of this term tends to reflect very small portable computers (smaller than laptops and notebooks). These devices provide portable computing for commercial applications such as bar code readers, capturing digital images, data and signatures. Recent developments in mobile computers aimed at the consumer market have made full XP functionality available on devices that are known as 'ultra portables' with a touch screen interface and USB ports for connecting keyboard, mouse and larger screens.

Actual use

The rapid development of the PDA market has largely taken over the consumer market in mobile computers, however these devices are extensively used in industry and commerce for tasks that include tracking transportation, parcel delivery, retail, field service, route accounting, warehousing, and industrial/manufacturing. The relatively high cost and low market penetration of mobile computers for consumers has restricted the growth of this market, but it is expected to become more popular as costs reduce and additional competition delivers better availability.

Potential

Use by specific industry sectors is likely to increase as more supply-chain processes are digitised. Lower cost consumer mobile computing will bring the ultra portables within reach of the higher end PDA market.

Convergence

Mobile computers for the consumer market have a very small market share, and it is likely that the more popular PDA and PC Tablet markets will dominate this market segment. At present, industrial applications have a low level of convergence with mobile telephony, however this market could change quickly as new opportunities are identified.

Mobile telephones (cell phones)

Intended use

Originally developed as simple portable telephones, mobile telephones are now becoming the preferred platform for an expanding number of applications and when combined with web access, are called smart phones. Wikipedia predicts that in a couple of years, most new phones will either be 'smart' or disposable.

Short Messaging System (SMS) or texting is the most frequently-used service after voice telephony. Additional features such as cameras (still and video), web, email, multi-media messaging (MMS) are readily available.

Actual use

The dominant use of mobile phones is for telephone and SMS although MMS is evolving rapidly.

The use of visual communications, both through still and video images, and through Multi-Media Messaging Services (MMS) is likely to become more popular as the current compatibility, distribution list and bulk messaging problems are overcome.

Satellite television broadcasts to third generation mobile phones have recently commenced in France (Sydney Morning Herald, June 29, 2005).

Potential

Mobile telephony has been embraced by young people who are, to a large extent 'pulling' the development of this technology. The wide-scale adoption of mobile phones indicates that both new uses, and new ways of using 'old' mobile phone products are very likely. Mobile telephones have become important in supporting young people's

social structures, therefore the social drivers of mobile telephone usage need to be considered along with new technological opportunities.

As new 3G handsets and software evolves it is expected that connection speeds will increase, giving users a more satisfactory experience when downloading applications, as well as a richer platform for multimedia content. (Ragus, 2005)

For those who hanker for hard copy of their digital masterpieces, it should become easier to print straight from mobile phones. Already you can take your phone to a photo outlet and print wirelessly with Bluetooth-equipped phones, and copy photos onto a memory stick or disk. NEC's N411i will include PictBridge, so photos can be printed directly from the phone to a PictBridge printer (Goggin, 2005).

Integration with other consumer products is also creating new uses for mobile telephones. Refrigerator manufacturers are experimenting with MMS Fridges that have internal web cameras to capture the image of the items inside the fridge so that users can use MMS on their mobile phones to see the contents of the fridge while at the supermarket, thus overcoming the need for shopping lists¹¹.

Convergence

Convergence of mobile telephones and PDAs is one of the strongest trends in current mobile technology development.

i-Pod/MP3 players

Intended use

Correctly named Digital Audio Players, DAPS are more commonly known as MP3 players because of the use of the MP3 file format. The dominance of Apple's i-Pod in the market has led to the term 'podding' and hence 'podcasting' for audio weblogs. Initially designed as a small, mobile music player, MP3 players can access data from CDs (in MP3 or other digital formats), flash-based solid state devices, and hard drive based players that can store up to 100GB of files. Some MP3 players can also be used as a flash storage device for other digital file types.

Actual use

The development of the audioblog or podcast has opened up MP3 technology to the e-learning sector through its capacity for downloading lectures or information as audio files. This process can be easily managed through RSS feeds (Really Simple Syndication or Rich Site Summary or RDF Site Summary) that provide short descriptions of content and a link to the full version of the content, and 'feed readers' or aggregators that check RSS feeds on behalf of the user. When combined with podcast receiving and management software (such as iPodder), which allow users to subscribe to and automatically download their favourite podcasts, content can be automatically delivered to a desktop computer or web-enabled portable device.

There are a growing number of educational podcast websites, and tertiary education providers and public broadcasters such as the Australian Broadcasting Corporation (ABC) and the BBC are increasingly making podcasts of lectures available online.

Audio files are attractive for listening 'on the move' and are an excellent delivery tool for audiences that have limited visual literacy, but they not necessarily efficient sources

¹¹ Elisa Batista: *Chilly Forecast for Smart Fridge* <http://www.wired.com/news/print/0,1294,59858,00.html>

of information because it is difficult to cue to a specific place in the file, and keyword search is not yet possible.

Potential

Most current podcast services are accessible to anyone with web access and good bandwidth (podcasts average a megabyte per minute of playing time, so a half hour lecture is 30mb). The future of podcasting includes narrow-casting, or access via password where only enrolled students are given access, or even audiblogs where students can record their own thoughts for others to download as audio files.

Convergence

MP3 players are now commonly integrated with flash storage drives, PDAs and PDA/mobile phone combinations. MP3 files can also be played on desktop computers.

PDA's

Intended use

The core features offered by Personal Data Assistants (PDAs) are address books, diaries and 'to do' lists, however current model PDAs support other software that includes dictionaries, games, street directories, time tracking, bookkeeping, sales management and trip managers. Some PDAs are 'smart' and have wireless web and email access. PDAs can both record and store data, with the most popular recording mechanisms being a stylus (with freehand writing recognition and entering data by tapping an on-screen keyboard) or a miniature QWERTY keyboard.

Actual use

The majority of PDA users simply access the software that is provided with the device, or access additional commercial software. However, there is increasing development of specific enterprise or industry-based software that supports real-time data collection in the field. The addition of remote synchronisation (via wireless or satellite in remote areas) makes the PDA a very useful tool for organisations that have mobile employees.

Potential

The increasing capability of PDAs and the market responsiveness to new and niche software opportunities indicates that the use of PDAs for mobile work and learning is still developing. The reduction in cost of base model devices, and the convergence with mobile phones and MP3 players means that the PDA/phone/MP3 combination may be a viable mobile learning tool for the mass market.

Convergence

The convergence of mobile telephones and PDAs is already creating a strong market position. It is not unreasonable to expect that future developments will add more functions and greater operating capacity to this already successful mix.

Portable media players (PMP)

Intended use

Hard disk or flash-based devices, similar to MP3 players, that are can store and play back more than one type of media format, particularly digital video. Current devices tend to be heavy and have low battery life.

Actual use

The market for current products is unclear. The playback from these devices can be directed to any display device, including televisions and computer screens.

Potential

PMPs have the potential to provide mobile learning materials that incorporate images. Expected developments include meta-data on media usage that would provide tracking feedback to Learning Management Software¹².

Convergence

As size decreases and battery life increases, PMPs technologies are likely to converge with other portable digital devices.

Portable video games

Intended use

Entertainment.

Actual use

Predominantly entertainment.

Potential

A number of developers have already produced educational programs for video game devices, the introduction of mobile communications into some portable video game products creates the opportunity for collaborative educational gaming.

Convergence

Mobile communications have already been introduced, and further exploration of the communications/gaming interface is expected.

Tablet PCs

Intended use

Tablet PCs are computers, shaped in the form of a notebook or a slate, upon which the user writes directly (using touch screen) or indirectly using a peripheral graphics or digitising tablet, without needing a keyboard or mouse. Tablet PCs can have a keyboard area, in which case they are called convertibles or hybrids, those that comprise only a monitor with a stylus are called slates.

Tablet PCs are not restricted in their processing speed or storage capacity, and as they mainly use Windows operating systems, they provide full PC functionality, which when combined with a touch screen or stylus interface with built-in handwriting recognition

¹² Maisie, 2005

(and frequently voice recognition) software to enter data or graphics, they are suited for industrial and commercial applications that use freehand drawing, or industrial applications and control systems. Tablets come in a range of sizes (usually between A6 and A3) and have the same wireless and wired Internet and intranet capabilities as other personal computers.

Actual use

PC Tablets can be very robust because they can be sealed against moisture and dust and withstand very hot or very cold conditions. Users therefore tend to be sector-specific, often incorporating software developed specifically for the sector or enterprise. Industries that are likely to use Tablets include: earth sciences, health care, transport logistics, and manufacturing. The introduction of Microsoft's Tablet PC Edition in 2002 made Tablets more accessible to the general public.

Potential

Currently the cost of PC Tablets at the upper end of the laptop price range is restricting their use by the general public, however their full PC functionality fills a gap in the market that is not currently addressed by PDAs or handheld computers (although release of Windows Mobile 5.0 with more powerful MS Office features may narrow the market gap). Manufacturers are targeting 'road warriors' and 'corridor warriors' – people who spend much of their time in meetings – and with a projected increase in sales, prices may be more competitive.

Convergence

The convergence of PC Tablets is similar to that of other mobile PCs, with little integration of voice telecommunications (mobile phones).

Web integration with appliances

Although web-enabled appliances are not yet mobile, they have been included because of their potential for web and telephone accessibility that is not tied to standard desktop computers.

Intended use

Some appliances (such as refrigerators) are available with embedded LCD displays that provide touch screen computing, television, Internet, and equipment maintenance and error checks. Similarly, televisions can be used as computer screens for large-screen display of web, CD-ROM and DVD content. It is expected that Internet access will become more ubiquitous in household appliances.

Actual use

Internet-enabled appliances are still very expensive when compared to non-Internet products, and as noted by Caslon Analytics, "the Internet fridge has been more photographed and written about than purchased ... and more purchased than fully used"¹³.

Potential

¹³ Caslon Analytics Note: *The internet fridge*, <http://www.caslon.com.au/fridgenote.htm>

According to *Assembly Magazine*, "Appliance manufacturers spent the past decade focusing on energy-efficient products. Today, their R&D efforts have shifted to harnessing the power of computer technology. Within 10 years, more than 90% of appliances will have computer processing capability allowing them to be networked and controlled from remote locations by cell phone or computer."¹⁴

Convergence

As Internet appliances become more accessible, other technologies will be integrated. It is not unlikely that hands-free Voice over Internet Protocol function will be included in the Internet appliance concept, thus allowing householders to work in the kitchen or laundry and conduct hands-free telephone conversations, or use the Internet via voice command.

¹⁴ Austin Webber: *Smart Appliances Spur Consumer Demand*
<http://www.assemblymag.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,6490,116951,00.html>

Appendix B: Palm-based curriculum

<http://learninginhand.com/>

Lesson Plans

The following activities use multiple Palm applications and take advantage of handheld computing. Many of these lessons could be adapted to Pocket PC handhelds.

Lesson Plan Title	Grade Level	Content Area
Adjective Fun	2-3	Language Arts
Angles in Art Lesson NEW!	5-9	Art & Math
Building Biographies: A Research Unit	4-6	Language Arts
Colour Theory & Using Layers NEW!	10-12	Art & Technology
Comparison of Multicultural Literature NEW!	4-5	Language Arts
Dinosaur Daze NEW!	4-5	Science
Discovering Decimals	4-6	Math
Experimenting with Pressure and Volume	9-12	Science
Exploring Integers	6-8	Math
Exploring Literature and Weather through Chirps	4-6	Math, Science, Reading
Exploring Roman Numerals	4-8	Math
Fables	3	Reading
Face It! NEW!	5-8	Art
Fairy Tales	3-7	Literature
Fun with Food	8-12	Spanish
Fun with the Food Guide Pyramid NEW!	6-8	Health
Fun with Heredity	5-12	Science
Genetically Inherited Traits	7-8	Science
Genres in Literature	3-6	Language Arts
Getting to Know Numbers	1-2	Math
Hear All About It	6-8	Language Arts
Idioms...not to be taken literally!	4-5	Language Arts
Jigsawing with Golden Sower Award Books	3-9	Language Arts
Let There Be Light	4-6	Science
Meet the Instruments of the Orchestra NEW!	2-5	Music
Mondrian: Rectangles, Squares, & Balance Oh My!	2-3	Art
Moon Exploration	3	Science
Nature and Fitness Trail	9-12	Biology
Note Names & Piano Games NEW	3-5	Music
Op Art and Contrast	7	Art
Palms and Literature	5-6	Reading
Reacting to Literature	5-6	Language Arts
Research, Production, and Presentation of Abstract and Pop Art NEW!	4-6	Cross-Curricular
Reference Resources: Being a Good Detective NEW!	4-6	Literacy
Scientific Research	9-12	Science
Self-Portraits	8	Art
Simple Machines	4-8	Science

Learning on the move
Mobile technologies in business and education

Social Change	4-6	Cross-Curricular
Space Trader & Economics	4-8	Social Studies
Stock Ownership & The Economy	9-12	Social Studies
The Important Things About Nouns NEW!	5-6	Language Arts
Tropical Ecosystems	4	Science
Vertebrates are Cool!	4-6	Science
Virtual State Tour	4-5	Social Studies
Vocabulary: Variety and Venture	6-8	Language Arts
Where Am I?	4-8	Social Studies
What Makes a Leader a Leader?	10-12	Marketing
Your Neighbourhood Geography	10	Geography

Appendix C: Primary Research

Interviews were held with:

ACPET
Adelaide High School
Australian Electronic Commerce Centre
Automotive Training Australia
Bright Cookie
Central Gippsland Institute of TAFE
Commonwealth Bank of Australia
Dale Spender
Department of Transport, Energy and Infrastructure (SA)
E-Works
LJ Hooker
Logan Institute of TAFE
Macro Dimensions
Marcus Ragus
Nokia
Northern Territory Open Education Centre
Onesteel Whyalla
Palm Australasia
Qantas
River Murray Training
RMIT
Salisbury High School
Services Industry Skills Council
Swinburne University of Technology
Transport and Logistics Industry Skills Council
University of Melbourne
Valley View Secondary School
William Angliss Institute of TAFE
Yambay Technologies

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Appendix D: Survey instruments

The surveys were conducted as guided interviews with the following instruments as prompts:

Mobile learning is courses, information or assessment delivered via wireless mobile devices such as PDAs (Palm pilots), mobile phones etc.

Manufacturer survey

Hi, my name is XXX and I'm doing research for the Australian Flexible Learning Framework into the use of mobile technologies for learning. Do you have a few minutes to answer some questions? Your answers will be confidential (although if there's a good quote we will ask your permission to use it)?

Q1 Company name _____

Q2 Your name _____ Phone _____

Q3 What are your main products in the mobile technology market? _____

Q4 For each of these products, what percentage is purchased for business purposes and what percentage is purchased for consumer use?

Business % _____ Consumer % _____

Q5 For business users, what *type* of organisation is the largest purchaser of your products?

Q5 You design products for certain uses, what else are these products being used for? (eg downloading lectures rather than music for MP3 players)

Product	Intended use	Emerging uses

Q6a Do businesses or consumers ever request technology solutions to make their practices easier or better? Y/N/D

Q6b If Yes, can you categorise the type of business or consumer that are likely to make requests, and the type of requests they make?

Type business/consumer	Request

Q6c What solutions or products have been developed as a result of business or consumer requests?

Q7 What future applications or capabilities are planned for existing products?

Q8 What is the trend for development of new mobile devices or technologies?

Q9a Are mobile devices that are specifically designed for educational use currently being produced or being planned? YND

Q9b If Yes, what...

Device	Educational use

Q10 Do you have any other comments about mobile technologies for learning?

Q11 Is there anyone else you would recommend that I speak to about m-learning...(please state name and organisation)

Name	Organisation

THANK YOU FOR YOUR TIME

(The report will be published by the Australian Flexible Learning Framework later this year – check the website if you are interested:
<http://www.flexiblelearning.net.au/projects/resources/2005/ResearchAndPolicyAdvice.htm>)

Education provider survey

Hi, my name is XXX and I'm doing some research for the Australian Flexible Learning Framework into the use of mobile technologies for learning. Do you have a few minutes to answer some questions about m-learning? Your answers will be confidential (although if there's a good quote we will ask your permission to use it)?

Q1 Name _____ Job title _____

Q2 Organisation _____ Contact phone _____

Q3a Is the use of mobile technologies for learning a frequent topic of discussion with students? Y/N/D

Q3b Is the use of mobile technologies for learning a frequent topic of discussion with staff? Y/N/D

Q4 What mobile technologies do you think your students are ready for? Why?

Ready for	Why

Q5a Are students in your organisation using mobile technologies for learning (such as PDAs, laptops, mobile phones, mp3 players)? Y/N/D

(If **NO**, go to Q10)

Q5b If yes, for what purpose are they using them?

Q6 Does the availability of mobile technologies present opportunities for new types of delivery or management of learning? Y/N/D

If YES, what opportunities: _____

Q7 In relation to the use of mobile technologies for learning, what learning outcomes are planned?

Q8 How is mobile learning structured into the curriculum?

Q9 How do mobile technologies fit into e-learning?

Q10 What type of student would use mobile technologies to:

Q11a Communicate with their teachers? _____

Q11b Communicate with other students? _____

Q11c Do research and gather information? _____

Q11d 'Timeshift' lectures or lessons? _____

Q11e Support group learning through activities such as collaborative projects?

Q12 Where are students likely to use mobile technologies?

- In the classroom
- In the library
- Around campus generally
- On public transport
- At home
- Other _____

Comment: _____

Q13 What mobile technologies do students like best and why?

Q14 What mobile technologies do teachers/lecturers like best and why?

Q14 Who decides or influences what mobile technologies students buy or use?

- Students themselves
- Parents
- Peers
- Course requirements
- Other _____

THANK YOU FOR YOUR TIME

(The report will be published by the Australian Flexible Learning Framework later this year –
check the website if you are interested:

<http://www.flexiblelearning.net.au/projects/resources/2005/ResearchAndPolicyAdvice.htm>)

Business survey

Hi, my name is XXX and I'm doing some research for the Australian Flexible Learning Framework into the use of mobile technologies at the workplace. Do you have a few minutes to answer some questions? Your answers will be confidential (although if there's a good quote we will ask your permission to use it)?

Q1 Name of Business _____

Q2 Contact name _____ Phone number _____

Q3 Nature of the business (industry type) _____

Q4a Number of employees in Australia _____

Q4b Number of employees worldwide _____

Q5 What mobile technologies is your company using for your normal business processes?
Number the responses to assist answering Q6

- CD-ROM
- DVD
- Flash storage devices
- GPS
- Laptops/notebook computers
- Mobile phones
- MP3 players
- PDAs
- Portable media players
- Portable video games
- Tablet PCs
- Web integration appliances/tools
- Wireless

Q6 How do you currently use each of the technologies you identified in the previous question:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Q7 Has your use of mobile technologies created:

Business efficiencies? Y/N/D Comment: _____

Greater productivity Y/N/D Comment: _____

Q8 If you haven't already covered this, what was the basis of the business case for using mobile technologies?

Q9 What do you see as the next evolution of mobile technology applications in your organisation?

Q10 What activities would you like to see made possible through mobile technologies?

11a On a scale of 1= not important to 5= essential,
How valuable financially are mobile technologies to your
organisation?

11b On a scale of 1= not important to 5= essential,
What is the value of mobile technologies to staff satisfaction?

11c On a scale of 1= not important to 5= essential,
What is value of mobile technology in establishing a competitive
edge?

11d On a scale of 1= not important to 5= essential
What value are mobile technologies in creating a business culture
that values new knowledge (a learning organisation)?

Q12 Do you use mobile technologies as a learning tool for your staff? Y/N/D

If NO, finish and thank them.

Q13 If YES, in what way? _____

Q14 If YES to Q13: Are you using mobile technologies for learning about the device and its uses, or are you using it the technologies to learn about other things? Device/Other

Q15 IF YES to Q13: Do you anticipate your use of mobile technologies for learning will change over the next 5 years? Y/N/D

If Yes, how? _____

What benefits will this provide? _____

THANK YOU FOR YOUR TIME

(The report will be published by the Australian Flexible Learning Framework later this year – check the website if you are interested:

<http://www.flexiblelearning.net.au/projects/resources/2005/ResearchAndPolicyAdvice.htm>)

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Glossary

21C	Twenty first Century
Blog	Web Log
Bluetooth	industrial specification for wireless Personal Area Networks
CD-ROM	Compact Disc Read-Only Memory
Cell phones	Mobile phones
GPS	Global Positioning System
Handhelds	Hand held computers (micros), PDAs
ICT	Information and Communications Technology
LAN	Local Area Network
Landline	Fixed cable telephone
MMS	Multi Media Messaging
MOPAS	Mobile Pilot Application Specification
PAN	Personal Area Network
PC	Personal Computer (desktop computer)
PDA	Personal Data Assistant
SMS	Short Message Service (also texting)
WAN	Wide Area Network
WAP	Wireless Application Protocol
Web	World Wide Web (the Internet)
Windows	MicroSoft Windows®

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