

Mobile learning in the 21st century: benefit for learners

Abstract

As the quantity of information available increases exponentially and the general pace of life accelerates, the ability to navigate, access, validate and share information will be a pivotal skill in an increasingly complex environment. This skill will affect every part of a person's existence, including everything from their ability to remain competitive in the workplace, to their ability to make personal choices about holidays, social activities and personal development projects.

This article proposes four fundamental learning advantages that are gained more easily, or to a greater degree, through the use of mLearning than through traditional face to face instruction, paper based distance education or traditional eLearning. Based on secondary academic research, and field research into current examples of mLearning, this article provides an alternative definition for mobile learning (mLearning) and predicts some characteristics of the future learning environment, including the increased importance of metacognitive and literacy skills. It is proposed that mLearning can provide access, context, collaboration and appeal advantages and additional facilitation measures for facilitators. Finally, a glimpse of the future will be provided including hypothetical examples.

Definition

mLearning is the acquisition of **any** knowledge and skill through using mobile technology, **anywhere**, **anytime**, that results in an **alteration in behaviour**.

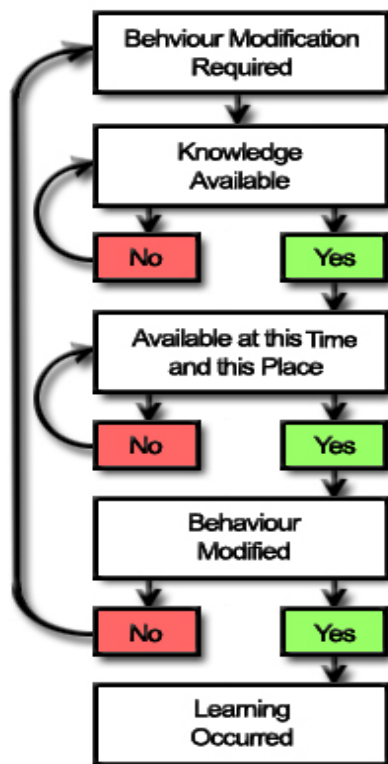


Figure 1. Mobile Learning

The following points are to be noted from this definition.

- The term 'mobile technology' refers to any device that is designed to provide access to information in any location, or while on the move. Specifically this would include, but not be limited to mobile phones, personal digital assistants (PDA), tablet computers and laptops.
- Terms such as teaching and training are not used in this definition. It is not suggested that these methods of facilitating learning will disappear, however, greater emphasis will be placed on self-directed learning.
- The behaviourist idea of an 'alteration in behaviour' is used because as the information age continues to progress, more people will be gaining more knowledge, more often and more easily. However, without an alteration in behaviour, it is not deemed to be learning.

Figure 1 is a graphic representation of mLearning, which in this instance is synonymous with flexible learning. It details the time issue by showing that *if* information is a) not available, b) not available at a certain time or place, or c) is the incorrect information, and does not result in the required behavioural change, *then* time is expended unproductively.

MLearning Advantages

Cutting edge information and communication technology (ICT) can most often be found employed within gaming, movies or other sectors of the entertainment industry. It generally takes 12-18 months for its adoption to cross over into mainstream industry learning applications (E. Masie, 2004. pers comm, 28 July). This mainstream industry adoption has been emerging over the last few years with some positive results. This article proposes four major advantages that can be gained from mLearning to a greater degree, or more easily than any other learning methods. The advantages are: access, context, collaboration, and appeal.

Access

The most obvious advantage of an mLearning environment is the ability to access information where it would not be possible without a mobile device. The salesman on the way to meet a client, the worker sitting on public transport, the emergency services personnel on the street and the list of examples goes on.

But how much would modern society actually use this facility if it were available? The increased requirement to undertake personal learning to maintain a competitive advantage in the global economy (Falk & Dierking 2002) has resulted in the average adult spending 15 hours per week conducting deliberate personal learning. Considering those 15 hours per week are not conducted at regular times or in regular places (Sharples 2003), the potential use is considerable.

That potential is likely to increase as the information age accelerates. People will need to be able access information faster and more effectively if they are to increase their employability, business success, personal fulfilment and social development (Lowey, 2003). mLearning provides people with the opportunity to access information where it would previously have been impossible.

This access advantage is not limited to time and location. The devices required to access mobile networks are relatively inexpensive compared to desktop or laptop computers (Savill-Smith & Kent 2003). This reduced expense can make access to this learning available to people who otherwise could not afford it.

Extensible Markup Language (XML) in the future could (if not XML then another similar markup language) allow those people, who only have mobile devices, to access a considerable proportion of the content and learning materials on the Internet. XML is a vendor, application and platform independent language that defines data and can be easily exchanged between systems and hardware. XML also has significant advantages with regard to data reuse and re-purpose. By applying the appropriate style sheet [Cascading Stylesheet (CSS) or XML Stylesheet language (XSL)] the same data can be displayed in any number of systems or hardware types (Ross et al 2004).

Context

There has been considerable research into the advantages provided by placing the learning situation into the work or application situation (Brown et al 1989, Bransford et al 1990, Kumar 1995, Schank & Cleary 1995). The research revolves around the ideals that meaningful learning will not occur unless it is anchored in an authentic task where the learner can experiment, make mistakes and learn.

It has been suggested that information technology can provide context through problem-solving activities in simulated authentic environments. Engestrom (1994) and McMahon (1997) contest this belief and claim that real world experience is gained from the real world, and that there has not been any research to prove that IT-based simulations are as effective.

Real time scenario and problem based learning activities can be conducted in the application environment through the use of mobile devices. A training scenario can be controlled centrally, in that global positioning systems (GPS) can be used to observe the location of the participants. Hence, the control of an IT-based scenario can be managed while still presenting the context of the real world. In addition, after the participant's movements and actions have been tracked and recorded during the activity, the records can be used as a post activity debriefing tool. An example of this is the Tate Modern multimedia tour pilot, which tracks the location of museum visitors and provides additional information of exhibits in their exact location.

Collaboration

Collaboration, as part of the social constructivism theory, emphasises the importance of intrinsic learning through social interactions (Vygotsky, 1978). This 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 (Stahl et al 1995).

This learner-centred collaborative approach is also well suited to ill-defined knowledge domains. It allows students to discuss complex situations and to resolve ambiguities, common in these domains (Spiro et al 1991).

Collaboration is not new to learning and would certainly continue to exist without the inculcation of mLearning into society. However, mLearning allows the collaboration to happen regardless of physical location, in real time and to include text and rich media as well as voice.

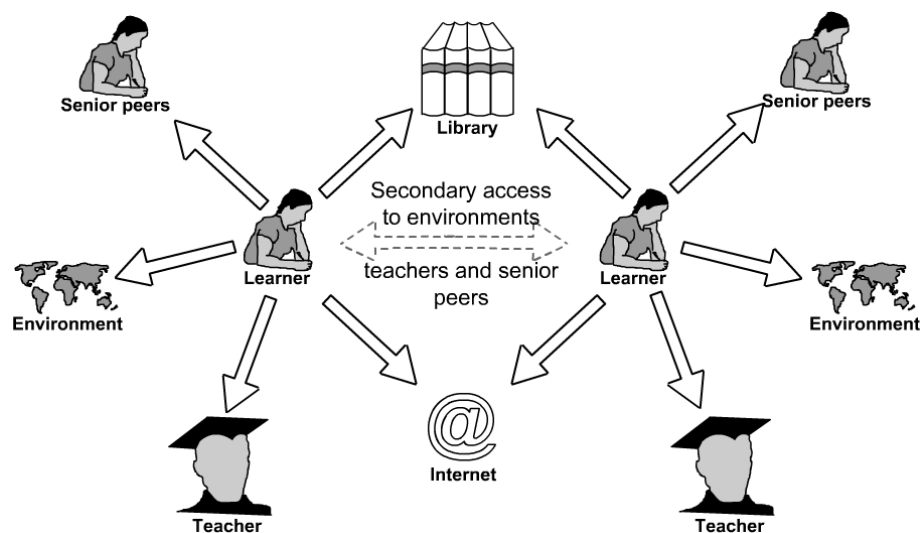


Figure 2. The Learner Centred Collaborative Environment

With the international commonality of communication over the Internet, collaborative environments can be international, therefore providing learners with secondary access to environments and international learning facilitators, which they would otherwise be unable to access. As wireless protocols become more common and accessible, learners will be able to participate in this international Internet communication.

Appeal

The ability to appeal to a learner is critical for his/her learning process. Mitchell and Doherty (2003) believe that the majority of m-Learning target audiences lack basic skills because they are not interested in taking part in traditional education and training.

An experiment is planned at Copenhagen University to provide PDAs with scanning pens to learners with reading difficulties. When learners discover a word with which they are unfamiliar, they scan the word. The scanning pen transfers the word to the PDA, which provides learners with an oral pronunciation and an oral and text definition on the PDA (T.M. Sorensen, 2004, pers. comm., 12 July). The interest here is not in the device, but in the ability to learn whenever and wherever is required and without being self-conscious of a lack of ability.

A correlation has been found between palmtop computers and an increase in student motivation (Attwell & Savill-Smith 2004). A casual observation of today's youth and their tendency to text message frequently would indicate they are interested in using these devices, as observed in Copenhagen where a girl in her mid teens was carrying on a conversation with friends while texting a message. This point is also clearly demonstrated by the following quote.

I love my PDA. I can't ever imagine lugging a laptop computer around with me, but I take this everywhere I go. When I baby-sit I do all my homework using my keyboard and the word processor, and I don't waste any time transcribing things later. I get so much more done in less time now (United States high school student, quoted in Pfeifer and Robb 2001, cited in Savill-Smith & Kent 2003).

Future learning

There is nothing new about the belief that the modern learner's needs are not being met by the most efficient methods. Spender and Stewart (2002) indicate that if educational organisations are to survive, they must move from a didactic to a more student-centred approach to learning, which is commonly referred to as the didactic teacher moving from the '...sage on the stage to a guide on the side' (McCown & Driscoll 1995).

Knowles (1984) presented two learning theories, which he called pedagogy and andragogy. He describes pedagogy as the art of teaching children, while andragogy is the art of assisting adults in the learning process. Assumptions from the andragogical model include that learners need to know why they need to learn; they want to know its value in advance; they want to be responsible for their own learning, and they have a task or problem-centred orientation to learning. Conversely, assumptions from the pedagogical model include students do not need to know why they are learning, students view themselves as dependant on the teacher, students become ready to learn when the teacher tells them and situated learning is of little value to learners (Knowles 1984).

A.M. Thorhauge (July 2004) has been conducting research at Copenhagen University, which may lead to a re-consideration of Knowles' drawing of the lines between pedagogy and andragogy. Although her research is not complete, the initial results indicate younger people may be more suited, and more able, to learn independently than previously believed by Knowles and those who follow his line of thinking. The experiment involved placing groups of adults and groups of youths in identical ill-defined problem situations in IT environments. The adults sat back and looked at the problem, established rules for the environment and came up with strategies to solve the problem. The youth, on the other hand, dove right in, made mistakes, altered approaches and re-attempted the problem. Two key results were found, (1) the youths' approach was more likely to solve the problem, and (2) when both groups solved the problem the youth would find the solution faster.

Part of the hypothesis from these results is that youth are better suited to this self-directed, experimental style of learning because they live in a more ill defined environment. They are accustomed to randomly searching the Internet for information rather than a library, and they play ill-defined domain computer games rather than the structured sports of the past (Thorhauge 2004). Additionally, one may consider that the 13 plus years the adults spent in a strictly directed didactic pedagogical learning environment may be part of the cause for their more rigid approach to problem solving.

These results bring Knowles' principles of the pedagogical model of learning into question and strongly suggest that young learners are capable of learning within an andragogical style environment. A learner's entire school experience could become a lengthy cognitive apprenticeship. As proposed by Brown et al (1989), part of this apprenticeship is the process of cognitive scaffolding. In the first few years of school, the teacher would build a cognitive scaffold for the learner to develop within. Once the learner has reached a level where they are capable of continuing their learning independently, the scaffold, or part of it, can be removed to allow progression with reduced assistance.

One issue with an increasingly diverse learner centred approach will be the ability of teachers to provide guidance to a group of learners who are not necessarily in one location, or working on identical problems as would be found in a didactic approach. mLearning can provide the teacher with another alternative important control measure in this situation. The progression of learners can be assessed through reports submitted to the teacher at set intervals. As the learners progress and become more confident and able, the frequency of these reports can be reduced (removing the cognitive scaffold).

The key for this approach to work is in the teacher's ability to access where the learners Zone of Intervention (ZI) (Kuhlthau 1997) exists. The fundamental principle of the ZI is that learners facing problems in this zone can be successful only with guidance from an instructor or more advanced peer. Intervention outside of this zone will be neither appreciated nor necessary. In addition, while the teacher is assessing the learners ZI, they will also have to assess the learner's ability in more generic skills. If a learner does not possess functional literacy skills, they will be unable to retrieve a great deal of information, and if the learner is not aware of how he/she learns (metacognitive skills) he/she will not be able to take full advantage of the learning process.

Literacy

In the past, literacy has been defined as the ability to read and write; however, as the information age of IT and multimedia progresses, the notion of what literacy entails has

moved beyond this (Lepani 1998). In modern society, literacy includes not only written, spoken and numeric literacy but also computer literacy (Wikipedia, no date).

A group of literacy pedagogy experts met in New London in 1994, during the meeting they coined the term 'multiliteracies'. The term was used to describe the multimodal nature of literacy when taking into account the World Wide Web and interactive multimedia (Fehring 2001). While the importance of multimodal literacy is acknowledged in modern society, the question is raised, is it being gained at the expense of traditional written literacy? This question is asked because of written literacy standards in Australia in 1996 detailed in Figure 4.

Literacy Standards in Australia		
Level	Percentage	General description
Level 1	20%	indicates a person with very poor literacy skills.
Level 2	27%	identifies individuals who, although they can read, can deal with only material that is simple, clearly laid out and in which the tasks involved are not too complex
Level 3	36%	denotes people with the ability to integrate several sources of information and solve more complex problems. This is the level of skill regarded by many experts as a suitable minimum for coping with the demands of everyday life and work in a modern society.
Level 4&5	17%	describes respondents who demonstrate the capacity to use higher order thinking and information processing skills. Since the numbers performing at the highest skill level are small (under five percent in most countries), Level four and five are combined for the purposes of data analysis.

Figure 4. Data from Australian Council for Adult Literacy ([ACAL](#)).

Regardless of the importance of multimodal literacy in the modern society, the requirement to read and comprehend is still essential to successful self-directed learning. No verifiable academic research data could be accessed to prove this assumption, so the author conducted an experiment to test the theory. Five search strings were selected by the author and placed into the Google search engine. The search strings were selected on the assumption they were more likely to yield results with high levels of content other than text (video, audio, graphics and animations), and because they were likely to be topics of interest to the younger generation. The search strings were video, animation, graphics, movies, and computer games. Each one the top five Google result home pages were checked for word content and other asset content.

The results of the Google search were 12,292 words to 340 multimedia assets. In addition, of the 25 web sites visited, only three used iconic symbols for navigation, and the majority of graphics and animations contained additional text not included in the word count. While it is acknowledged this does not constitute a scientific experiment, and it is not possible to draw a direct parallel between a word and a multimedia asset, the point is made that it is not possible to successfully access and understand all information, even in a multimedia rich environment, if a person cannot read and comprehend.

This ability, also known as critical literacy, is the ability to analyse and critique information when it is coming in a wide array of formats. During the information age, this ability to access, validate and understand information in a combination of written, audio, video, multimedia and social formats will be essential for successful life long learning (Tasmanian Department of Education 2004).

Some may argue that the existence of text to voice generators is one possible solution to this literacy problem; however, they still disadvantage those who lack skills. Firstly, most people can read faster than they speak, and secondly, transferring paper based text from books to electronic text, then to voice, is a time consuming process. It is widely acknowledged that the pace of life will continue to increase as we progress into the information age. By that rationale, a text to voice generator should be used for listening at times when activities being undertaken make it impossible to read, but not as a substitute for the ability to read. (These are assumptions. Further research is required.)

Metacognition

Metacognition is a learner's ability to reflect on their thinking and to control their cognitive processes (Collins, Dickson, Simmons & Kameenui, no date). A metacognitive analysis is conducted in three phases:

- during performance (reflect in action),
- after performance (reflection on action), and
- accessing metacognitions prior to, and during, future performances (Flavell, 1981).

In self-directed learning it is imperative that learners be able to understand and learn from all experiences, not only for their own growth, but for the growth of their peers in a collaborative environment. In the self-directed learning process much of the experience-based knowledge gained is tacit, which is often taken for granted and although the learner may believe something to be correct or incorrect, the learner may not necessarily know why. The reflective process of metacognition allows the transfer of this tacit knowledge to explicit knowledge (Wilson, Jonassen and Cole 1993). This explicit knowledge can then be shared.

Without metacognitive skills, it is likely much of the potential learning will be missed, which will affect future learning experiences. As described by Russo, Evensen & DiVesta, (1997), metacognitive skills determine what is known, which in turn contributes to what is observed, what is observed helps determine additional knowledge requirements which determine what action is needed to be taken to gain the additional knowledge.

Even in modern society, it is very uncommon for individuals to be taught how to learn effectively (Lowey 2003). This is a concern when research shows that people perform better in post-test and delayed test activities after having being instructed in metacognitive skills (Tanner and Jones, 1995).

Current Employment of mLearning

The following examples are of real life, currently employed, uses for mLearning. Although this list is far from exhaustive, they cover the advantages detailed previously in this article.

1. The KLIV Project.

Malmo Hospital and Malmo University in Sweden are conducting the KLIV project. It involves employees at Malmo hospital accessing videos on how to use various pieces of equipment in the hospitals intensive care unit (ICU).

The process for developing and employing the videos follows a five-step procedure.

1. The employees determine what equipment requires video assistance for ease of use.

2. The employees discuss the video requirements and plan the shoot.
3. The employees make videos of the equipment being used, detailing sequences and any complex steps involved.
4. The video is reviewed informally and then formally.
5. The video is either then remade, or deployed into the hospital for use by employees.

Bar codes are placed on any equipment in the ICU with videos available. The employee approaches the piece of equipment and scans the bar to receive the appropriate video demonstration without needing to remember the name of the equipment.

The primary advantage here is faster and easier access to information, although the entire process is learner centred and promotes collaboration in that as a group they collaboratively decide what videos need to be made, and then they make and informally review them.

2. An mLearning system for scaffolding bird-watching learning (Chen, Kao & Sheu 2003)

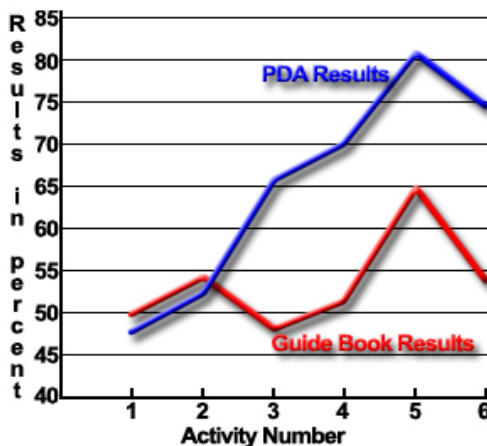


Figure 5. Bird Test

Forty three students from three Taiwanese schools were selected to partake in an experiment to determine the effectiveness of PDAs in field situations. The students were to examine local species of birds and follow a series of questions designed to guide their learning process rather than test their knowledge. Twenty one students took digital photos of the birds, transferred them to a PDA where they searched for the information to answer the questions. Twenty two students used telescopes to spot the birds, searched for the information in a paper based guidebook and then received the question orally. The results from the experiment are detailed in figure 5.

The article on this experiment did not offer any reason for the increased results from using the PDA. One possible assumption is an increase in interest with the new format and an increase in the ease of accessing information from the PDA rather than transferring to a book.

3. Tate Modern multimedia tour pilot.

There is nothing unusual about collecting an audio guide system when visiting a museum. Tate Modern has taken this to the next level. Its tour system is able to provide background context to works in rich media and interactive formats via a PDA rather than just audio. In addition, a wireless location finding system allows the mobile device to provide the correct information in the correct location without being promoted. This saves the learner having to find the correct section in the devices memory for the work they are looking at. The network also allows the user to request information to be sent to their email address, along with promoting other tours and activities in the museum.

The predominate advantage here is the ease of access to information and the ability to store it as required. The notification system for events also provides users with a better context of their surroundings in the museum.

4. The Mobile Technologies for Mobile Learning (MoTFAL) Project

The MoTFAL project involved collaboration between schools in Greece and Spain. The students from Spain would take digital camera enabled PDAs (in the future this will include video) into archaeological sites in Spain. The students in their classroom in Greece would text requests for information and photos to the Spanish students who would then comply and respond. The students would also describe distances and send photos with students in front of artefacts to provide an idea of size. This process would then be completed in reverse.

The main advantage here is collaboration between the students, with the sharing of information and questions resulting in both parties asking and answering questions they may not otherwise have thought of. There is certainly the possibility of an increase in appeal with the interactive nature of the media compared to a text book, and the ability to provide some context by observing people in locations.

5. Dodgeball

Dodgeball is a social interactive game used in many major cities in the United States. Members of the community can access the location of friends, events, or ping their location to anyone within a 10 block radius. This is not a learning application; however, remembering that learning applications of technology are around 12-18 months behind the cutting edge, we can expect to see this type of location finding application being used in learning activities. It has real possibilities in controlling large area scenario style training activities. In addition, by maintaining a record of incidence in the scenarios, participant locations and reaction, the playback of the scenario in a central location after the conclusion could provide a valuable feedback tool.

The future

One predominant vision for the future is one of Ambient Intelligence (Aml). Aml is the vision that technology will become invisible, ubiquitous, enabled by effortless interactions, and aware of and autonomously adaptive to, its environment and users. It will provide high quality information and will be available to any user, anywhere, at any time, and on any device (Lindwer et al 2003). The following models are potential examples of Ambient Intelligent Learning (AMIL) Environments. These models are predictions for future learning based on what is expected to be possible within an AMIL environment. The traffic accident example is modified from the mobile white paper (C Quinn 2004, pers. comm, 4 August).

Future model 1. The travelling salesperson

A salesperson boards a plane to travel across the country for a meeting with a large client. Just after take off the salesperson receives an email on their PDA¹ detailing a competitors' just released product. The salesperson then alters the sales pitch to take into account this new information and prepares to answer questions on the topic. After landing the salesperson stops at the hotel to freshen up and receives news broadcast on the television, inside the bathroom mirror, indicating an unfavourable change in economic

¹ MIT Technology review has announced that Boeing is planning on making broadband wireless Internet contentions available on flights.

conditions. The sales person, then in the taxi on the way to meet the client, conducts further research into this change and prepares to alleviate the clients' concerns.

This constitutes learning which is not only 'just in time', but is also 'just in existence'. Through reflection on this learning (metacognition) the learner can transfer these lessons to long term knowledge and associate them to relevant existing cognitive structures.

Future example 2. The traffic accident

A group of emergency services personnel are on route to a traffic accident. Their PDAs retrieve information on the traffic accident provided by the cars involved². The PDA is aware of the location of the accident and starts uploading data on the accident and the location.

All PDAs are aware of their users and start uploading relevant information in preparation. A police officer is provided details on the best method of securing the accident and detouring traffic based on the accident and the local environment. A fireman is provided details on the types of vehicles and fuels being used, the location of the nearest hydrants and general vehicle accident information. The ambulance drivers on route are receiving information on likely injuries, methods of treatments and the best route to the nearest hospital based on the local traffic conditions, including the police planned detour. Additionally, the two ambulance drivers include one who poses high levels of logical intelligence, while the other poses high level visual intelligence (Gardner 1993), the devices format the information in accordance with their requirements.

Future example 3. The broken lesson

A busy executive awakes one morning and commences an eLearning lesson for work. Halfway through the lesson the executive stops and heads off to work. While on the train, the executive takes out his mobile device, which is aware of the last lesson being conducted, provides a brief transcript of content covered, then continues with the lesson. Before the lesson can be finished the executive heads off the train and starts walking to work. At this point in time a formative assessment was about to commence, so the executive transfers to voice mode, listens to the questions and answers them orally. After the assessment the lesson continues orally while the PDA records graphics that the executive has not been able to see. A particular subject interests the executive so he asks the PDA to source further information on the topic. The PDA comes back with a list of papers of which the executive selects one, the PDA converts the text to voice as the executive continues to walk to work.

Conclusion

As we progress through the 21st Century, and the already hectic pace of our lives increases, society will need to find faster and more inventive ways to utilise previously unproductive time. Life long learning will be essential for maintaining a competitive advantage in the global economy, for personal growth, and for simply functioning efficiently in an increasingly technological environment. With an increasing requirement to conduct learning activities independently, the ability to read and comprehend, and to

² MIT Technology review has detailed the new smart airbag system that sends accident data to emergency services personnel regarding the speed of the accident, number of vehicles involved and the number of times the vehicle has rolled.

metacognitively analyse and understand our learning processes, will be key factors in our successful development and our ability to function in the 21st century.

These requirements and skills can be improved through the use of mLearning. It provides access to learning during previously unproductive times, it allows more flexible and immediate collaborative options, it allows controlled learning in contextual situations, and provides greater options for teachers to observe and assist in independent learning.

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