The Seven, no eight, nine C's of Mobile Learning

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THE SEVEN 'C'S - NO, EIGHT - NO NINE 'C'S OF M-LEARNING

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ABSTRACT

Unless we have a clear understanding today of how and where tomorrow's technology can be used to support effective learning, educational developments will continue to be technology driven rather than learner driven. This paper identifies theories from the fields of cognition and educational psychology that can usefully be employed to explain the interactions between the user and their mobile device in a variety of mlearning contexts. In particular, examples from projects conducted at the Graduate School of Education (GSoE) involving trainee teachers and students in science using handheld PDAs are used to illustrate pertinent teaching and learning opportunities.

The theoretical approaches that appear to be most relevant to mlearning are those that stem from the constructivist approach to learning, involve learner control and challenge by setting an appropriate level of complexity, provoke their user's curiosity and allow them to engage in active learning conversations with a sense of confidence as they come to know and understand. Furthermore, mobile devices enable context aware and collaborative learning which offer opportunities for further engaging students and enhancing their learning. Building these concepts into software and activities designed for mlearning will support and motivate future learners.

Whilst acknowledging that mobile devices have a key role in supporting informal, serendipitous learning at point of need; the paper itself focuses on theoretical underpinning for the future successful use of mobile technologies within the formal school and university based curricula.

KEYWORDS

Mobile learning, PDA, handheld computer, constructivism, cognitive theory, conversational learning

1.   RELEVANT THEORETICAL APPROACHES FOR M-LEARNING

Constructivism

Naismith et al (2004) introduced a classification of mobile learning activities where they categorised examples of learning via personal digital assistants (PDAs) and mobile 'phones that involved children and the general public as well as university and college students, into six areas, four of which relate to the underpinning learning theory. These are behaviourist, constructivist, situated and collaborative. Two further categories relate more to context and application; informal and lifelong learning, and learning and teaching support. Of these six, I believe the constructivist approach is most helpful in terms of describing learning with mobile devices. Behaviourism considers only the relationship between a student's action and the response they receive without acknowledging any intermediary cognitive processing. And for me, situated and collaborative are more descriptions of ways in which learning may take place that could themselves be built into a constructivist learning activity rather than grounding theories within themselves.

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

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

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

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

Control

Papert (1980) also attached importance to the concept of the learner 'owning' the problem making the activity of constructing personally meaningful. This sense of increased engagement of the learner controlling their learning by means of information technology has been noted for a while but not yet investigated on a large scale. In an early review of the use of databases in classroom practice Underwood (1994) linked valued learning experiences with ICT to the ways in which students take responsibility for the learning outcome and pointed out how new technologies could support a move to more independent approaches to learning. In fact using software to provide an open learning environment, encouraging student autonomy and choice, has seen as good practice in ICT teaching in the United Kingdom for a number of years now (NCET/NAACE, 1994). Davis et al (1997) argued that the degree of autonomy that secondary school pupils had over the pace and content of their learning with ICT was directly related to an increase in the quality of learning itself.

This was tested empirically by Wishart (1990) who investigated the effects of the three cognitive factors; user control, challenge and visual complexity on motivation to use and learning from an educational computer game. The game itself was intended for use by young children, written for the BBC micro and illustrated how to get out of a house fire safely. 300 primary school students played different versions of the game which had been constructed to provide user control of movement through the house, challenge through scoring points and visual complexity through use of graphic effects in different combinations. Control through user choice was found to be the most significant factor in creating involvement with and learning from the software.

Jones (2006) in Sharples' report on the Kaleidoscope big issues in mobile learning workshop described the importance of control as a feature of the relationship of users with their mobile devices. In particular she noted the relationship between control and the strength of association between the use of mobile devices and

informal learning. Learners often find their informal learning activities more motivating than learning in formal settings such as schools because they have the freedom to define tasks and relate activities to their own goals and control over their goals. There are now many examples of PDAs being used to support informal learning within the UK. These include Caerus in the University of Birmingham's botanical gardens, the Tate gallery in London, Mobile Bristol and the Queen's Square riots.

Young children in the schools participating in the Learning2Go project are controlling the PDAs in and outside school with ease. The teachers in this project in Wolverhampton, UK are reporting that these students are doing more work at home and bringing into school more information gathered outside school than before they were given the mobile devices (Whyley et al, 2006).

As well as a sense of autonomy over when and where to learn feeling in control of the device clearly matters. One of the ITT students testing a Palm OS device in the first GSoE PDA project (Wishart, Ramsden and McFarlane, in press) was so frustrated by her inability to operate it in the way she wished to that she reported "I feel pure hatred for my Treo – it beats me every time." More usually the simplicity with which PDAs could be controlled was viewed positively by the ITT students who cited the 'instant on' feature, the multiple functions such as alarm clock, remote controller, camera and the variety of input mechanisms as benefits. Also controlling the physical presence of the device itself; being able to hide the PDA in a pocket or handbag when not needed was reported favourably by the students compared to other sizeable computers that could get between them and the class.

Conversational Learning

Interestingly Jones (2006) also referred to cybernetic theory pointing out that adjusting or controlling your role in a system is empowering. It was the cyberneticist Gordon Pask (1976) who originally considered learning as a system. He did not distinguish between human- human and human-machine systems but considered interaction in both as a dynamic process, in which the participants learn from and about each other. Pask (ibid) put forward a view of learning as a conversation within such a system.

When applied to mlearning this concept of a conversation both reinforces and illuminates the process of coming to know by constructing knowledge in a two-way interaction between student and mobile device (O'Malley et al, 2005). Sharples (2003) points out that there are two possibilities for the role of the mobile device within this interaction or 'conversational space'. One possibility is for the computer to take the place of the teacher as in traditional computer-aided instruction. The problem is that it only covers part of the conversational space as even expert tutor systems are limited by their algorithms and cannot explore students' misunderstandings in any detail. An alternative is for the technology to provide an environment that enables conversations between learners. This extends the range of learning activities into other worlds through games, software models and simulations and to other parts of this world by using the PDA as a means of communication, through phone, email and computer based discussions.

Sharples (2003) adds that a mobile learning device can assist conversational learning by integrating learning descriptions across different locations and by holding the results of learning actions for later retrieval and reflection. The ITT students in the GSoE PDA project (Wishart, Ramsden and McFarlane, in press) stored notes and observation in both Word and Calendar for use in reflective assignments.

The concept of the computer as a communication channel enabling highly interactive conversations was first proposed by Pea (2002). He also noted the importance to the learner of access to stored data such as archives of information, knowledge, and representations of past activities that can be read, drawn upon, and extended as needed. Pea (ibid) proposed that, through such channels, information technologies have the potential to act as cognitive tools for augmenting human performance in complex tasks and for learning. Thus by considering the learner and the technological tool such as computer or mobile device as a single system we have a model where the information to support cognitive activities is distributed between the learner, the computer's memory and the internet.

Pea (1993) had already suggested that the use of information and communications technology (ICT) affords distributed intelligence. Perkins (1993) aptly described such working as 'Person Plus' and the GSoE study (Wishart, Ramsden and McFarlane, in press) showed that with an internet enabled PDA the ITT students did indeed become 'Teacher Trainees Plus'. In that study the software applications most able to support Perkins' (ibid) notion of 'person plus' were the calendar or diary scheduler for organising yourself, the spreadsheet of attendance or mark book for organising your pupils, the web browser to answer yours and the pupils' questions and the use of a word processor to make notes on information and events immediately they are encountered.

Motivation to Learn with Mobile Devices

Challenge, Curiosity and Complexity

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

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

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

Confidence

Lepper et al (1993) noted that the motivational goals of feeling challenged and feeling confident are linked. An expert system devised to teach should ensure its students maintain a perception of self-efficacy for feelings of confidence and self-esteem have long been linked to successful learning.

Participants of all ages have been reported as confident in their use of PDAs, from 9 year olds in the Learning2Go project (Whyley et al, 2006) to sixty-plus year old nurses (Treadwell, 2005). The ITT students in the GSoE project (Wishart, Ramsden and McFarlane, in press) reported a feeling of confidence connected with having access to the internet wherever they were via PDAs. The search engine Google was particularly useful in this respect as it was simple and quick to use and the information returned with each hit was usually enough to answer the immediate query. On at least two occasions student reported feeling good about gaining

the respect of teaching staff as having the PDA enabled them to retrieve information their mentors needed but could not themselves obtain.

Collaboration

Increased confidence can also linked to opportunities for using the handhelds for collaborative learning. Ramsden (2005) found in his study of undergraduate Economics students that having a PDA allowed the students to hold question and answer sessions via an online discussion board during lectures. The students reported that they found this particularly helpful and Trinder (2006) suggests such PDA use could be particularly supportive for students with confidence difficulties who, in addition to having an open discussion board, could also beam their peers privately with their questions.

One of the ITT students in the GSoE project (Wishart, Ramsden and McFarlane, in press), a Physics specialist, was being asked such complex questions about the biology of the heart in a lesson he was teaching he passed the students' questions on to his medical student friends via MSN.

A particularly successful example of collaborative learning amongst children through the use of PDAs has been developed by Miguel Nussbaum and colleagues at the University of Santiago in Chile. This is now being trialled in Wolverhampton schools as the EDUINNOVA project. It comprises a series of learning activities that involves assigning children in a class randomly to groups of three who then work together to solve a series of challenges on their individual PDA. The challenges are created or edited by the class teacher as appropriate for that day's lesson. The nature of the Eduinnova activity design means that each group member must play a part and the software allows the teacher to have oversight in real time of each group of students' progress. Whyley et al (2006) reports that teachers have been particularly impressed by the degree of cooperation that results, even between children who normally find it very challenging to work together. Children who would not normally speak to one another quickly settled to work.

Context: Situating Learning

One of the most exciting aspects of PDA use in schools for a science teacher is how having a handheld with camera and location awareness (via GPS) can enable both context relevant learning outside the classroom and bringing data and images taken from the outside world into the school to situate learning in a context known to the pupils. However, situated learning theory as originally described by Lave and Wenger (1991) involves social interaction and collaboration as well as an authentic context and is usually unintentional. In the following examples of PDAs being used to enhance and support fieldwork the learning is clearly intentional. The PDA activities involving images and background information are motivating and strengthen the link between concepts learned and context where they are found.

Fieldwork in science and geography, using mobile devices to bring context related information into the classroom, was one of the first successes for mlearning within formal education. Soloway (1999) describes several early examples from schools in the United States using Palm handhelds and probeware in the field. In the UK the Booted up Bristol project (Squire, 2005) is now working with nearly 300 schoolchildren a year to investigate a local river and nearby woods using PDAs and MP3 players as well as more traditional kit such as a compass and nets. Each school is provided with a CD of all their data, images and sounds and a curriculum pack of ideas and useful website links to continue their learning back at school. One headteacher reported that "This was the best piece of geography fieldwork he'd done in 17 years of teaching".

Further innovation involves adding GPS functionality to add location specific information which enables students, even young pupils to report useful data for national surveys such as those carried out on carbon monoxide levels and noise pollution by the Participate project in Bath, UK (Oldroyd, 2006). In the first phase of this project students from secondary schools in Bath combined their data with the Google Earth software to produce a stunning visualisation of pollution levels over the city. Trials on a fieldtrip to Wales for the

Wolverhampton PDA project (Whyley et al, 2006) showed that Year 6 learners using a Bluetooth GPS unit and Memory Map software were able to track themselves on their Ordnance Survey map walk and embed photos, videos and word files of their experience to create a multimedia real time field trip log.

2. DISCUSSION AND CONCLUSIONS

In their extensive review of pedagogical theory for mlearning created as part of the international Mobilearn project O'Malley et al (2005), suggest that theories of learning must be tested against the following criteria

> • Do they account for both formal and informal learning?
> • Do they analyse the dynamic context of learning?
> • Do they theorise learning as a constructive and social activity?

The combination of a constructivist approach encouraging learner control of interactive learning 'conversations' with a handheld device, with software engendering challenge and curiosity set within a pertinent context and allowing for collaborative learning is extremely powerful. It creates confident learners and clearly fulfils O'Malley et al's (ibid) proposed criteria.

Though I earlier separated the theories in order to describe them – this is not in fact the case. These cognitive aspects of learning are interdependent and combined in a complex web creating motivation and understanding. Byrnes (1996) noted the way in which students can become intrinsically motivated when they have control over their environment, set challenges for themselves and satisfy their curiosities. Lepper et al (1993) first applied this combination to computer based learning in their proposal that an expert tutoring system should maintain the learner's sense of personal control, enhance confidence, produce an appropriate level of challenge and elicit a high level of curiosity. Sharples (2003) adds that the interaction between learner control and success is complex. Successful self-management of learning comes as a result of developing competence and skill in learning how to learn, ie how to form connections and construct mental schemas. Specifically with mobile technologies learning can also be seen to be effective when control is appropriately distributed among the learners through collaborative working within a shared environment.

Ravenscroft (2000) points out that successful conversational learning itself comes when the learner is in control of the activity, able to perform experiments, ask questions, and engage in collaborative argumentation. Sharples (2003) adds that the mobile learning device assists conversational learning by integrating context, for example by making connections between exhibits in a museum, and by supporting constructivism through holding the results of learning actions for later retrieval and reflection. He considers that in reviewing learning through mobile technologies, we may well come to conceive of education as conversation in context, enabled by continual interaction through and with the personal, mobile device (Sharples, 2005).

Thus the power of learning seen in the examples above of students using mobile devices appears to be a human response to the way in which this new learning technology enables each and every aspect of that complex web of interlinked cognitive concepts to resonate together during episodes of learning.

The current challenge is to untangle this complex web in order to provide clear direction for teachers, lectures, software and hardware designers for future development of mobile devices and learning and teaching activities. O' Malley et al (2005) suggest extended activity theory (Engeström, 1987) as a way of usefully describing theoretical approaches to mlearning and have indeed used it to create a number of helpful pedagogical guidelines for setting up learning activities with mobile devices. However, whilst enabling a descriptive framework, activity theory does not help us understand the entwined, interconnected, involving cognitive web described in this paper. We need to look to further research – perhaps within the field of cognitive developmental psychology applied in educational contexts to help.

However, for the moment, it is enough that software and hardware manufacturers and educational developers pay attention to these key concepts that so clearly underpin the success of mlearning.

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