

## **A Theory of Learning for the Mobile Age**

Mike Sharples, Josie Taylor, Institute of Educational Technology, The Open University  
Giasemi Vavoula, School of Museum Studies, University of Leicester

Throughout the world, people are learning in new ways due in part to the proliferation of mobile technologies and media. Increasingly, in technically developed countries, learning resources are 'just there', ready-at-hand, with users of mobile devices forming complex patterns of mobility, interaction and collaboration. In developing countries lacking an infrastructure of phone lines and cables, mobile devices offer the only means to find information and share knowledge at a distance. Yet, mobile learning involves far more than accessing educational content on small devices; it compels us to reconsider the experience and context of a mobilised learner, the role of teacher and technology in supporting the process of meaning making, how people actively create sites for learning as they move across locations, and how to support sustainable communities of learners equipped with powerful personal technologies.

This contrasts with conventional views of education as imparting knowledge at a fixed location of a classroom or lecture hall. As the complexity increases of the interactions between learners, educational settings and mobile technologies, this invites a more expansive possibility of ubiquitous learning supported by personal media communicators. Theories of learning outside the classroom such as those proposed by Argyris (Argyris & Schön, 1996), Friere (Freire, 1996), Illich (Illich, 1971), and Knowles (Knowles & Associates, 1984), are pertinent, but these do not address mobility of learners and learning in a world mediated by personal interactive technologies.

This chapter proposes a theory of learning for a society of ever-increasing personal and social mobility. Our conceptualisation of mobile learning encompasses both learning supported by mobile and wearable devices, and also learning in an era characterised by mobility of people and knowledge (Rheingold 2002) where the technology may be embedded in fixed objects such as 'walk up and use' information terminals.

The focus of our analysis is communicative interactions among learners to advance knowing. At a first level of analysis we shall make no distinction between people and technology, but explore the dynamic system that comprises people and technology in continual flux. We shall show how this leads to learning as a conversational process of becoming informed about each other's 'informings', to cognition as diffused amongst interactions and reciprocally constructed conversations, and context not as a fixed shell surrounding the learner, but as a construct that is shaped by continuously negotiated dialogue between people and technology. We shall indicate how this allows us to understand the ecologies of learning in a world of networked mobility. It also leads to intrinsic contradictions, relating to the status of technology in learning

and ownership of the means of communication. We suggest that we can only begin to resolve these contradictions by understanding the relationship between traditional and mobile learning, and by creating a society in which learning as a global conversation can be given a central role in our system of education.

### **Criteria for a theory of mobile learning**

A first step in postulating a theory of mobile learning is to distinguish what is special about mobile learning compared to other types of learning activity. The obvious, yet essential, difference is that it starts from the assumption that learners are continually on the move. We learn across space as we take ideas and learning resources gained in one location and apply or develop them in another. We learn across time, by revisiting knowledge that was gained earlier in a different context, and more broadly, through ideas and strategies gained in early years providing a framework for a lifetime of learning. We move from topic to topic, managing a range of personal learning projects, rather than following a single curriculum. We also move in and out of engagement with technology, for example as we enter and leave mobile phone coverage (Vavoula & Sharples 2002).

To portray learning as a labile activity is not to separate it from other forms of educational activity, since some aspects of informal and workplace learning are fundamentally mobile in the ways outlined above. Even learners within a school will move from room to room and shift from topic to topic. Rather, it illuminates existing practices of learning from a new angle. By placing mobility of learning as the object of analysis we may understand better how knowledge and skills can be transferred across contexts such as home and school, how learning can be managed across life transitions, and how new technologies can be designed to support a society in which people on the move increasingly try to cram learning into the gaps of daily life.

Second, a theory of mobile learning must therefore embrace the considerable learning that occurs outside offices, classrooms and lecture halls. Findings from the seminal studies by Tough in the 1960s (1971), later replicated in Canada and elsewhere (Australian Bureau of Statistics 2007; Livingstone 2000; Hague and Logan 2009; Lai et al. 2011), exposed the volume of everyday, self-directed, informal learning undertaken daily by people from all walks of life. In the UK, a study by Vavoula (2005) of everyday adult learning, based on personal learning diaries, found that almost half (49%) of the reported learning episodes took place away from home or the learner's own office, i.e. the learner's usual environment. The learning occurred in the workplace outside the office (21%), outdoors (5%), in a friend's house (2%), or at places of leisure (6%). Other locations reported (14%) included places of worship, the doctor's surgery, cafes, hobby stores, and cars. The learning may or may not be directly related to the location. An example of a connection between location and learning was an international postgraduate student learning the names of different kinds of foreign beer in a pub while conversing with friends – one of the many cultural learning experiences that person had over the course of studies abroad. An example of no connection was a person discussing with a colleague over coffee at a bar and discovering references related to their work.

A central concern must be to understand how people artfully engage with their surroundings to create impromptu sites of learning. They may learn about their surroundings, for example on a geology field trip or a visit to a heritage site (Meek et al., 2013). They may learn in their surroundings, employing resources that are ready to hand to solve a problem or satisfy curiosity. An example from Vavoula's diary study illustrates this, where the diarist wants to learn how to pre-program a video recorder and so creates a context for learning from a recorder, a television and a friend with some knowledge of video technology who offers explanations and clarifications. Or people may learn despite their surroundings, for example by putting on headphones to block out distracting noise. Technologies for seamless learning (Milrad et al., 2013) promise a continuity of connection across locations.

The range of settings, situations and activities that qualify as mobile learning have expanded to encompass all of formal, non-formal and informal learning – distinctions that were previously made with reference to location, learning goals and visibility of outcome (Commission of the European Communities 2000; Falk 2005; Mocker and Spear 1982; Tough 1971). By researching all these types of learning together, we are starting to discover the myriad of experiences that contribute to learning (Falk 2004). To exclude an experience because it takes place at the wrong site, or because it was unintended, or because the learning objectives were vague, or because we cannot immediately discern the learning outcomes, is to ignore – to borrow Livingstone's (2000) metaphor – the hidden part of the iceberg of learning.

This view renders learning almost indistinguishable from everyday experience and calls for a theory of mobile learning that replaces the dichotomy between learning and non-learning with a recognition (in fact, celebration) of the learning potential of everyday encounters, emphasising the importance of context in the learning process. That is not to say that a theory of mobile learning is a theory of all human experience; but that it should anticipate that learning contexts will emerge from human interactions, and that interaction-enabling mobile technologies will bring about new dimensions of context (Westera 2011).

This brings us to the third criterion, that a theory of mobile learning must take account of the ubiquitous use of personal and shared technology. In Europe there are more mobile phone subscriptions than people, and worldwide mobile phone subscriptions total 95% of the global population (International Telecommunications Union, 2014). These figures mask the huge disparities in access to technology around the world, but they indicate a trend towards ownership of at least one, and for some people two or three, items of mobile technology including mobile phones, tablet computers and wearable devices. A trend relevant to a theory of learning in the mobile world is that some developing countries, particularly in sub-Saharan Africa, are by-passing fixed network telephony to install mobile phone networks in rural areas. These offer the opportunity for people in rural communities not only to make phone calls, but to gain the advantages of mobile services such as text and multimedia messaging. For example, the BBC Janala service in Bangladesh provides daily three-minute audio lessons on mobile phones to adults wishing to improve their English language skills (BBC, 2014). Anyone can learn and practice English by calling a mobile short code, for the cost of 50 paisa (half a penny) a minute. In the first two years of the project

nearly 24 million people (a quarter of the adult population in Bangladesh) accessed this mobile media.

We are now seeing a well-publicised convergence of mobile technologies, as companies design and market smartphones, combining into a single device the functions of phone, camera, media player and multimedia wireless computer. Another equally important convergence is occurring between the new personal and mobile technologies and the new conceptions of learning as a personally-managed and socially-networked lifelong activity (Table 1).

<b>New Learning</b>	<b>New Technology</b>
Personalised	Personal
Learner centred	User centred
Situated	Mobile
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

Table 1. Convergence between learning and technology

Just as learning is being re-conceived as a personalised and learner-centred activity (Leadbetter, 2005), so too are new digital technologies offering personalised services such as music play-lists and digital calendars. Just as learning can be seen as a situated and collaborative activity (Brown, Collins, & Duguid, 1989), occurring wherever people, individually or collectively, have problems to solve or knowledge to share, so mobile networked technology scales up people’s ability to gain and share information wherever they have a need, rather than in a fixed location such as a classroom.

Computer technology, like learning, is ubiquitous -- computers are embedded in everyday devices such as photocopiers and televisions. Computing is also becoming more durable, in that although the hardware may last only for two or three years, personal software packages and storage formats (such as PDF) evolve through successive versions, with a large measure of backward compatibility. Personal technology now offers people the opportunity to preserve and organise digital records of their learning over a lifetime (Banks, 2004).

Lastly, to be of value, a theory of learning must be based on contemporary accounts of practices that enable successful learning. Two reports published by the US National Research Council, one in 1999 that synthesised research into formal learning environments (Bransford et al. 1999) and a second in 2009 that synthesised research into informal learning environments (Bell et al. 2009), help highlight common elements of effective learning environments:

- learner: learners' prior interests, knowledge, skills and identities are integral to learning, enabling them to interpret their own experience.
- knowledge: multifaceted, dynamic portrayals of validated knowledge provide the foundations for instruction, which makes inventive use of concepts and methods to provide multiple ways for interaction and physical, emotional and cognitive engagement.
- assessment: assessment is matched to the ability of the learners, offering diagnosis and formative guidance while assessing cognitive, intellectual, attitudinal, behavioural, sociocultural and participatory dispositions and capabilities.
- community: successful learners form a mutually promotive community, sharing knowledge and supporting less able learners.

These findings broadly match a social-constructivist approach, which views learning as an active process of building knowledge and skills through practice within a supportive group or community (for an overview, see Kim, 2000). Palinscar (1998) defines it as the appropriation of socially derived forms of knowledge that are not simply internalised over time but are transformed in idiosyncratic ways during the appropriation process, thus rendering interaction, negotiation and collaboration as the primary prerequisites: active students explain to, discuss among, and cooperate with each other; teachers participate in the design and facilitation of these activities; dynamic assessment targets developing abilities rather than learned knowledge.

To summarise, we suggest that a theory of mobile learning must be tested against the following criteria:

- is it significantly different from current theories of classroom, workplace or lifelong learning in accounting for the mobility of learners?
- does it cover formal, non-formal and informal learning?
- does it theorise learning as a constructive and social process?
- does it analyse learning as a personal and situated activity mediated by technology?

From these general criteria we propose a definition of learning for the mobile age as 'the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies'. We shall now attempt to unpack the definition, indicating how conversation and context are essential constructs for understanding mobile learning, and offering implications for the ownership of learning and the integration of mobile learning with conventional education.

### **Learning as Conversation**

Central to our definition is the claim that conversation is the driving process of learning. The description we give here of learning as conversation is primarily based on the work of Gordon Pask (Pask, 1976). It derives from cybernetics, the study of communication and control in natural and artificial systems, and its more recent extension to second order cybernetics, the study of the mechanisms by which a system

can understand itself. This 'radical constructivism' (von Glaserfeld, 1984) extends the notion of learning as a constructive process beyond individuals to describe how distributed systems including teams, organisations and societies learn and develop.

Conversation is seen by Pask as the fundamental process of learning, the means by which people become informed about each other's 'informings' (what Pask described as the "coordination of coordinations of coordinations") (Scott, 2001). Higher level coordinations are 'tokens' for lower-level coordinations, (objects and events), which are themselves tokens for stabilities of sensori-motor activity and "structural coupling" with the environment. To constitute a 'conversation', the participants must be able to formulate descriptions of themselves and their actions, explore and extend these descriptions and carry forward the understanding to a future activity. In order to learn, a person or system must be able to converse with itself and others about what it knows.

Thus, conversation as a process of shared meaning making is fundamentally different to communication as a passing of messages. Conversations for learning are the means by which we negotiate differences, understand each other's experiences and form transiently stable interpretations of the world. Freire (1996) refers to "co-intentional learning", where teacher and learner jointly develop understanding through dialogue.

The teacher is no longer merely the one-who-knows, but one who is himself taught in dialogue with the students, who in turn while being taught also teach. They become jointly responsible for a process in which all grow. (Freire, 1996, p. 61)

Central to these learning conversations is the need to exchange descriptions of understandings. This may involve producing and sharing language-based descriptions (speech, text), visual representations (diagrams, concept maps, photographs), embodied communication (gestures, facial expressions), or other media communications. To be able to engage in productive conversation, all parties need access to a common language and tools that enable the construction of shareable representations of the subject matter; which in turn allow the conversing parties to identify and discuss topics. Negotiation of meaning and understanding through these acts is deliberately designed to take into account the conversing parties' interpretive contexts and resources (Kress 2009).

Pask's Conversation Theory has been applied by Laurillard (2002) and by Sharples (2003) to describe the processes involved in learning conversations supported by technology. Laurillard proposes that for learning to succeed, the student must:

- apprehend the structure of the discourse
- interpret the forms of representation
- act on descriptions of the world
- adjust actions to fit the task goals
- adjust descriptions to fit the topic goal
- reflect on the cycle of goal, action, feedback

Some educational activities, such as science lab classes, are explicitly designed to support this structure of conversation. Most conversations, though, cover only one

part of the framework, either because the learner has no conversational partner available, or there are no tools for model building to hand, or learners lack the language and concepts to converse at the level of descriptions. That is where technology can assist. Laurillard's conversational framework describes a conversation between learner and partner. The partner may be a teacher, or another learner - or it may be computer interactive technology.

Technology may play a range of roles. It may take the place of the teacher, as in drill and feedback. It may provide or enrich the environment in which conversations take place. It can provide tools for collecting data and for building and testing models. It can extend the range of activities and the reach of a discussion, into other worlds through games and simulations, to other parts of this world by mobile phone or email, and through multiple modalities including textual, visual and haptic (touch). The technology provides a shared conversational learning space, which can be used not only for single learners but also for learning groups and communities. Technology can also demonstrate ideas or offer advice, as with the worldwide web or online help systems, or through specific tools to negotiate agreements, such as concept maps and visualisation tools.

In all these conversations (among learners and teachers, between learners and interactive technology) there is a fundamental need to establish and sustain a language that can enable shared understanding. One means to do this is through 'teachback' (a term coined by Pask) where one person attempts to re-describe what they have learned, to check if it matches the understanding of the other participants in the conversation. This can form part of deliberate learning or can occur naturally, for example when we repeat back a set of instructions over the telephone. It does not mean that every concept must be negotiated and agreed. Such rigour rarely occurs in practice, and pinning down the meaning of terms can often be counter-productive. A debate over the meaning of language can inhibit discussion, so social solidarity can often be fostered by ignoring precision (Boyd & Pask 1987).

So far we have described conversations for learning as taking place in the abstract, but every human partner to a conversation is situated in one physical location; while every computational partner embeds the assumptions, orderings and prioritisations of its designers. A significant problem with learning conversations in a mobile world is that not only does the language of communication need to be continually negotiated, but also its context.

### **Context and learning**

All activity is performed in context. Cole (1996) makes an important distinction between context as "that which surrounds us" and context as "that which weaves together". This mirrors the distinction made in the technical literature on pervasive computing between context as a 'shell' that surrounds the human user of technology and context as arising out of the constructive interaction between people and technology.

The 'context as shell' model, exemplified by the Shannon-Weaver (Shannon & Weaver, 1949) informational model of communication, situates the learner within an environment from which the senses continually receive data that are interpreted as

meaningful information and employed to construct understanding. Thus, a learner in a classroom may receive information from a teacher, a whiteboard and a text book, all of which must be assimilated and integrated to form a composite understanding of the topic being studied.

But learning not only occurs in a context, it also creates context through continual interaction. The context can be temporarily solidified, by deploying or modifying objects to create a supportive workspace, or forming an *ad hoc* social network out of people with shared interests, or arriving at a shared understanding of a problem. But context is never static. The common ground of learning is continually shifting as we move from one location to another, gain new resources, or enter new conversations (Lonsdale et al., 2003).

Traditional classroom learning is founded on an illusion of stability of context, by setting up a fixed location with common resources, a single teacher, and an agreed curriculum that allows a semblance of common ground to be maintained from day to day. If all these are removed, as may be the case with learning in the mobile age, then creating temporary islands of relatively stable context is a central concern. In this respect, the historic construction of context, the process by which we arrive at current understanding, assumes greater importance.

Current activity can only be fully understood by taking an historical perspective, to understand how it has been shaped and transformed by previous ideas and practices (Engeström, 1996). This is particularly true of mobile learning, where both the immediate history of activity and the wider historical process of coming to know merge to create new understanding. For example, a visitor to an art gallery stands in front of a painting. She has arrived at a current understanding of the painting from the path she has taken through the gallery – taking in the ambience, stopping at other paintings, reading the guidebook – and also from a lifetime of creating and interpreting works of art starting with childhood drawings. In one sense, context can be seen as an ever-playing movie, with each frame of current context being a progression from earlier ones and the entire movie being a resource for learning. But it is a movie that is continually being constructed by the cast, from moment to moment, as they share artefacts and create mutual understanding through conversation.

### **The dialectical relationship between learning and technology**

We have characterised learning as a process of coming to know through conversation across continually re-constructed contexts. Now, we turn to the role of computer and communications technology in that process. The study by Vavoula (2005) showed that 52% of everyday learning episodes involved one or more pieces of electronic technology: mobile and fixed phones, laptop and desktop computers, televisions and video recorders. To support mobile learning according to our definition, it is not necessary that the device itself be portable. Our definition of mobile learning embraces both learning with portable technology, and also learning in an era characterised by mobility of people and knowledge.

Vavoula's studies showed that people create settings for learning out of technology or resources that are ready-to-hand. For example, a person is driving through London by



car with his partner who is reading about tourist sites on her smartphone. Simultaneously, they pass an on-street sign outside a museum advertising a new exhibition. Currently, these two aspects of mobile learning (learning with portable devices and learning while mobile) are somewhat separate but they are starting to converge, as handheld and wearable devices interact with their surroundings and static objects respond to people on the move. Thus, in the Caerus project (Naismith, Sharples & Ting, 2005) visitors to the University of Birmingham botanic gardens were given handheld location (GPS) devices that automatically offered audio commentary on the flowers and shrubs as they walked around the gardens. Or in the Talking Statues project (Baraniuk 2013) people walking around the streets of London and Manchester can swipe their phone on a nearby tag to receive a phone call from the statues they met and hear them tell their stories. Conversely, museum visitors can wear ‘active badges’ that identify them to the fixed exhibits and displays, which provide information tailored to their interests (Bristow et al., 2002). With 4G phone connections, cloud computing, public access internet computers, and screens linked wirelessly to devices, people are now able to create *ad hoc* spaces for individual or shared learning, deploying a combination of mobile and fixed technology, in homes, tourist locations or hotel lobbies (Sharples, 2003b).

A paradox arises from this analysis. In order to understand the complexity of learning we need to analyse a distributed system in which people and technology interact to create and share meaning. But putting people on a level with computers and phones fails to take account of the unique learning needs and moral worth of each individual person. We have attempted to address this paradox by describing the activity system of mobile learning, in a way that problematizes the dialectical relationship between people and technology.

Following Engeström (1996), we analyse learning as a cultural-historical activity system, mediated by tools that both constrain and support the learners in their goals of transforming their knowledge and skills. As with Pask’s Conversation Theory, the model (Figure 1) describes a system of activity amongst interacting people and objects, showing the structural properties of the system. In the model, the ‘subject’ is the focus of analysis (for learning systems, the subject is typically a learner). The ‘object’ refers to the material or problem at which the activity is directed. This is shaped and transformed into outcomes through mediating artifacts, including tools and signs. Engeström analyses the collective activity of groups and societies through an expanded framework that shows the interactions between tool-mediated activity and cultural ‘rules’, ‘community’ and ‘division of labour’. As we have adapted Engeström’s framework to show a *dialectical relationship* between technology and semiotics, so we have taken the liberty to rename the cultural factors with terms – ‘control’, ‘context’ and ‘communication’ – that are in the currency of both learning theorists and technology designers, to assist dialogue between the two professions. Of course, this risks the possibility that the terms will be interpreted differently by both groups and simply lead to misunderstanding and mutual incomprehension, so we shall attempt to clarify their meaning.

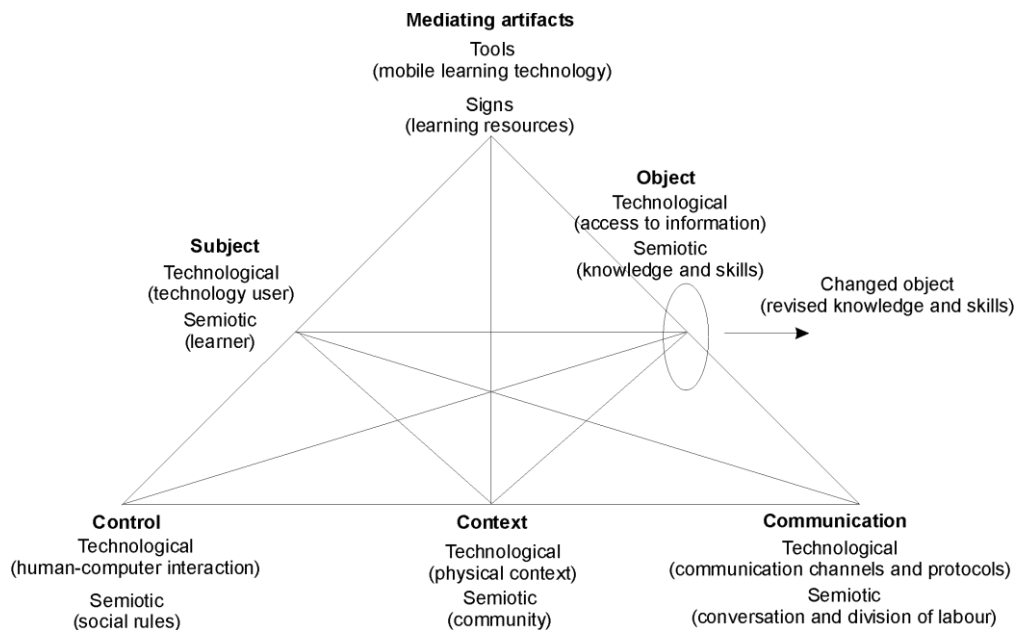


Figure 1. A Framework for analysing mobile learning.

To explain the role of technology in learning we separate two perspectives, or layers, of tool-mediated activity. The ‘semiotic’ layer describes learning as a semiotic system in which the learner’s object-oriented actions (i.e. actions to promote an objective) are mediated by cultural tools and signs. The learner internalizes public language, instantiated in writing and conversation, as private thought which then provides the resource for control and development of activity (Vygotsky 1978). The ‘technological’ layer shows learning as an engagement with technology, in which tools such as computers and mobile phones function as interactive agents in the process of coming to know, creating a human-technology system to communicate, to mediate agreements between learners (as with spreadsheets, tables and concept maps) and to assist recall and reflection (as with blogs and online discussion lists).

These layers can be prised apart, to provide either a semiotic framework to promote discussion with educational theorists to analyse the activity and discourse of mobile learning, or a technological framework for software developers and engineers to propose requirements for the design and evaluation of new mobile learning systems. Or the layers can be superimposed (as in Figure 1), to examine the holistic system of learning as interaction between people and technology. Here, the semiotic fuses into the technological to form a broader category of technology than physical artefacts.

We need to make clear that, for our framework, we are neither proposing the separation of the semiotic and the technological, nor the fusing of the two. Rather, we want to set up a continual dynamic in which the technological and the semiotic, as discrete entities, can be moved together and apart, creating an engine that drives forward the analysis of mobile learning.

#### *Control*

Control is an ambiguous term. It can refer to the exercise of power by one individual or organisation over another. Or it can describe the ways in which a complex dynamic system can regulate itself, whether that system is a single human (‘self-control’) or a

distribution of people and technologies (e.g. environmental control of a building). These conceptions of control may be combined, notably in a classroom where a teacher exercises power over pupils and also must manage the classroom to enable a dynamic process of learning (Dillenbourg, 2013).

Outside the classroom, control of learning may rest primarily with one person, as teacher or guide, or it may be distributed among the learners, for example on a field trip or museum visit when groups of students explore the environment and discuss their findings. Control may also pass between learners and technology, for example in a dialogue for computer-based instruction. The technological benefit derives from the way in which learning is delivered: whether the learners can access materials when convenient, and whether they can control the pace and style of interaction. These are issues of human-computer interaction design.

However, technology use occurs within a social system of other people and technologies. Social rules and conventions govern what is acceptable (e.g. how to form a message in Twitter, what kinds of language should be used on Facebook). A person's attitudes to technology can be influenced by what others around them think about it, for example, whether they are resentful at having to use the technology or are keen and eager to try it out. Individuals and groups can also express informal rules about the ways they like to work and learn.

#### *Context*

As we have proposed earlier, the context of learning is an important construct, but the term has many connotations for different theorists. From a technological perspective there has been debate about whether context can be isolated and modelled in a computational system, or whether it is an emergent and integral property of interaction (see for example Lonsdale, Baber & Sharples 2004) who describe an interactional model of context for mobile learning). Context also embraces the multiple communities of actors (both people and interactive technology) who interact around shared objectives, mutual knowledge, orientations to study, styles and strategies of learning.

#### *Communication*

The dialectical relationship between the technological layer (of learners' engagement with technology) and semiotic layer (of learning as an activity mediated by tools and signs) is perhaps the easiest to see in relation to Communication. If a technological system enables certain forms of communication (such as email or texting), learners begin to adapt their communication and learning activities accordingly. For example people are increasingly going online at home, creating networks of interaction through phone conversation, texting, email and instant messaging that merge leisure and work activities into a continuous flow of conversation. As they become familiar with the technology they invent new ways of interacting – text message short forms, Facebook pages, Skype calls – that create new rules and exclusive communities (Grinter & Eldridge 2001).

This appropriation of technology not only leads to new ways of learning and working, it also sets up a tension with existing technologies and practices. For example, children can subvert the carefully managed interactions of a school classroom by sending text messages to each other hidden from the teacher. On a broader scale,

technology companies develop markets for new mobile technology to support interactions such as file sharing and instant messaging, pursuing their commercial interests and agendas while influencing the practices of learning. Commercial and technical tensions of innovation, technical superiority, openness, and interoperability are played out among learners as technology envy, online bullying and sharing of inappropriate content.

### **Process of appropriation**

We propose that there is a dialectical relationship between items in the technological and the semiotic levels of the mobile learning framework. This enables us to represent something of the process of appropriation that occurs when people are using technology to support their learning. Waycott (2004) provides an account of the internal workings of this process. When faced with a new tool, people examine both the possibilities and constraints it offers. This leads to a process in which the users adjust the 'fit' of their tools to their activities. Sometimes tools will cause their users to change their own behaviour to accommodate a feature or shortcoming in the tool. Sometimes users will shape the tool to suit their specific requirements. Doing either of these may initiate further changes as the users begin to exploit the technology and thereby enter an indirect conversation with technology designers and digital content producers, hence the dialectical nature of the process.

Thus, there is a continual co-evolution of technology and human learning (Bruckman 2004), with individuals, groups and societies simultaneously developing new modes of interacting with technology (such as text messaging and tweeting) in parallel with adopting new patterns of learning (such as just-in-time learning and mobile collaborative learning). Technology evolves in response to changing patterns of use, such as social networking, and usage evolves with new technologies, such as digital watches and wearables. In this dynamic embrace between technology and its use, each new development in either learning or technology creates pressures that drive the next innovation.

### **Education in the mobile age**

Our aim has not been to celebrate experiential learning, nor to promote learning through informal knowledge sharing as intrinsically more valuable than institutional education. Instead, we have attempted to explore the system of learning enabled by mobility of people and technology, through an analytic framework that does not assume either that learning arises from individual experience, nor that education only occurs in a traditional classroom mediated by a teacher.

Activity Theory can be employed to identify tensions and contradictions in activity systems which typically inhibit the subject from achieving the object of the activity. The classic example of a contradiction provided by Engeström, taken from Leont'ev (1981), is between the vocation of a doctor, who is impelled to heal the sick and make everyone well, but who also has to make a living, so must hope that people do not stop being ill. One consequence of our analysis of learning as a technology-mediated process of coming to know through conversations across contexts is that it reveals

new contradictions within institutional education. These tensions do not arise from some wish by the authors to challenge formal education; they already exist in society.

A world in which children own powerful multimedia communicators and where they practise new skills of online file sharing, informal text communication and content creation does not fit easily with traditional classroom schooling. It challenges the classroom as an environment in which both the structure and content of discourse are regulated externally by the curriculum and the examinations system, and where communications are mediated by the teacher. The carefully bounded discourse of formal education contrasts with the rich interactions that children engage in outside school, through mobile calls, texting and computer messaging, and by conversing in online communities. These two worlds are now starting to conflict as children bring mobile phones into the classroom or share homework online.

The analysis of learning as a conversational system might imply that a teacher has no ontologically privileged position, but is simply another participant in a continual conversation. We recognize that our theory of mobile learning does not give sufficient importance to what it is that makes a learning activity more valuable, to the role of teachers in promoting effective learning, to classrooms as well-organised locations for study, and to educational institutions in extending and validating learners' knowledge. Traditional education needs to be explored in relation to the new world of global knowledge and mobility. It is not sufficient to assert that authoritative knowledge is always located in the specialist professions and disciplines. Nor can we say that knowledge emerging from the new conversational communities such as Wikipedia is more trustworthy because it is the product of many inter-regulating minds, or invalid because it has been created through a self-organising community rather than by a body of experts.

Describing learning as a process that extends beyond individuals to distributed systems that learn and develop, raises issues about the ontological role of technology as a participant in learning. In distributed learning systems as they have been described here, learning and cognition are diffused. The creation of meaning lies in the act of exchange: the unique interaction that takes place between the elements of the system (humans or technology) within a distributed context. The learning system as a whole evolves in a continuum of advancing knowing through conversations and interactions. Knowledge is embodied in both the elements of the system and their interactions. At the end of a learning episode, what the elements take away is knowledge in the form of the experience of the learning system that was. This cyclic process underlies the continually changing activity systems we represent.

Finally, the view of learning as the process of coming to know through continuous conversations across multiple contexts amongst people and interactive technologies, raises the issue of where the ownership of learning lies. We argue that learning systems need to take shared ownership of learning. The agency is not with a single individual, nor with the technology. It lies in the democratic synergy between the different parts of the system with the aim to advance knowing. Learning needs to be conceptualised in terms of interactions between individuals, humans or non-humans, which take place in order to achieve evolving states of knowing as they are shaped by mutually (and continuously) negotiated goals. Such a concept, of shared ownership of the development of knowledge raises tensions with copyright and intellectual

property, as is being shown in the growing Open Source ([www.opensource.org](http://www.opensource.org)) and Open Learning initiatives ([www.open.edu/openlearn/](http://www.open.edu/openlearn/)). It also conflicts with corporate agendas embedded in commercial platforms such as Twitter, Facebook, or Google Docs that become sites of learning.

The implications of this re-conception of learning as conversations across contexts are profound. It removes the solid ground of (formal, non-formal and informal) education as the transmission or construction of knowledge within the constraints set by a curriculum or a learning agenda, and replaces it with a cybernetic process of learning through continual negotiation and exploration of context through conversation. This can be seen as a challenge to formal schooling, to the autonomy of the classroom and to the curriculum as the means to teach the knowledge and skills needed for adulthood. But it could also be an opportunity for technology to bridge the gulf between formal and everyday learning. Instead of seeing mobile communication and online communities either as a threat to, or panacea for formal education, we need to explore how learning can be transformed for the mobile age through a dialogue between two worlds of education: one in which knowledge is given authority through the curriculum, the other in which it emerges through negotiation and a process of coming to mutual agreement.

Such a reconceptualisation of learning has implications for educational policy and practice. As mobile devices and media become embedded into society, the top priority must be to empower everyone to engage in conversations for learning. Second, teacher professional development should be extended to support teachers in orchestrating learning conversations within and outside the classroom. Digital literacy can no longer be an optional extra on the teacher's skillset. The third, and perhaps most challenging, implication is on educational assessment and evaluation. The value and relevance of current assessment models has already been questioned within the education sector (Black & Wiliam, 1998). Acknowledging that learning is diffused across a range of contexts and conversations puts further strain on methods of assessment, calling for a radical rethink of the assessment and validation of learning.

New mobile and context-aware technology can enable young people to learn by exploring their world, in continual communication with and through technology. Instant messaging, for example, enables people to create learning communities that are both contextual, in that the messages relate to locations and immediate needs, yet unbounded since the messages can be exchanged anywhere in the world. Mobile technology can also enable conversations between learners in real and virtual worlds, such as between visitors to a museum or heritage centre, and visitors to its virtual counterpart. A person standing in front of an exhibit has the benefit of being there, of experiencing the full physical context, whereas the visitor to an online museum can call on the rich informational resources of the worldwide web. Education in the mobile age does not replace formal education, any more than the worldwide web replaces the textbook. Rather it offers a way to extend the support of learning outside the classroom, to the conversations and interactions of everyday life.

## **Acknowledgements**

This paper is a revised version of one that was published in the first edition of the The Sage Handbook of Elearning Research. It has benefitted from discussion amongst members of the Philosophy of Technology Enhanced Learning Special Interest Group of the Kaleidoscope European Network of Excellence, and by detailed written responses from the members of the group to an earlier draft. We are also grateful to the MOBIlearn 5th Framework IST project (IST-2001-37440) for supporting extensive research into the theory and practice of mobile learning.

## References

- Argyris, C., & Schön, D. (1996). *Organizational learning II: Theory, method and practice*. Reading, Mass: Addison Wesley.
- Australian Bureau of Statistics (2007). Adult Learning Australia 2006–2007. Retrieved on 11/03/15 from [http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/C617A03C5C06B489CA2573B70011D427/\\$File/42290\\_2006-07.pdf](http://www.ausstats.abs.gov.au/Ausstats/subscriber.nsf/0/C617A03C5C06B489CA2573B70011D427/$File/42290_2006-07.pdf)
- Banks, B. (2004). E-Portfolios: Their Uses and Benefits. Retrieved 8<sup>th</sup> September, 2014, from [http://archive.excellencegateway.org.uk/media/ferl\\_and\\_aclearn/ferl/resources/organisations/fd%20learning/e-portfolio.pdf](http://archive.excellencegateway.org.uk/media/ferl_and_aclearn/ferl/resources/organisations/fd%20learning/e-portfolio.pdf)
- Baraniuk, C. (2013). Talking Statues: Picking up the phone to Joan of Arc. *Native*. September 2013. Retrieved on 11/03/15 from <http://artsdigitalrnd.org.uk/features/talking-statues-feature/>
- BBC (2014). *Millions of Bangladeshis learn English with BBC*. Retrieved 8<sup>th</sup> September 2014 from [http://www.bbc.co.uk/mediaaction/where\\_we\\_work/asia/bangladesh/bbc\\_janala.html](http://www.bbc.co.uk/mediaaction/where_we_work/asia/bangladesh/bbc_janala.html)
- Bell, P., Lewenstein, B., Shouse, A.W., and Feder, M.A. (Eds.) (2009) *Learning Science in Informal Environments: People, Places, and Pursuits*. National Academies Press.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in education*, 5(1), 7-74.
- Boyd, G., & Pask, G. (1987). Why do instructional designers need conversation theory? In D. Laurillard (Ed.), *Interactive Media: Working methods and practical applications* (pp. 91-96). Chichester: Ellis Horwood Ltd.
- Bransford, J.D., Brown, A.L., Cocking, R.R., Donovan, S., Pellegrino, J.W. (Eds) (1999). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academy Press.
- Bristow, H. W., Baber, C., Cross, J., Woolley, S., Jones, M., (2002). *Minimal Interaction for Mobile Tourism Computers*. The Workshop "Mobile Tourism Support" at MobileHCI 2002. Retrieved 8<sup>th</sup> September, 2014 <http://www.eee.bham.ac.uk/pcg/docs/Mobiletourismv4.1.pdf>.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*(January-February 1989), 32-42.
- Bruckman, A. (2004). Co-Evolution of Technological Design and Pedagogy in an Online Learning Community. In S.A. Barab, R. Kling and J.H. Gray (eds.) *Designing for Virtual Communities in the Service of Learning*. Cambridge: Cambridge University Press.

- Cole, M. (1996). *Cultural psychology: A once and future discipline*. Cambridge, MA: Harvard University Press.
- Commission of the European Communities: Memorandum on Lifelong Learning (2000).
- Davis, J. (2001). Conceptual Change. In M. Orey (Ed.), *Emerging perspectives on learning, teaching, and technology*. Retrieved 8<sup>th</sup> September 2014, from <http://epltt.coe.uga.edu/>
- Dillenbourg, P. (2013). Design for classroom orchestration. *Computers & Education*, 69, 485-492.
- Engeström, Y. (1996). *Perspectives on activity theory*. Cambridge: Cambridge University Press.
- Falk, J. (2004). The director's cut: Toward an improved understanding of learning from museums. *Science Education* 88, p. S83-S96.
- Falk, J. (2005). Free-choice environmental learning: framing the discussion. *Environmental Education Research* 11(3): 265-280.
- Freire, P. (1996). *Pedagogy of the Oppressed*. 20th anniversary edition revised. NY: Continuum.
- Grinter, R. E. and Eldridge, M. (2001). y do tngrs luv 2 txt msg?, in W. Prinz, M. Jarke, Y. Rogers, K. Schmidt and V. Wulf (eds.): *Proceedings of the Seventh European Conference on Computer-Supported Cooperative Work ECSCW '01*, Bonn, Germany. Dordrecht, Netherlands: Kluwer Academic Publishers, pp. 219-238.
- Hague, C., and Logan, A. (2009) A review of the current landscape of adult informal learning using digital technologies. FutureLab. [http://archive.futurelab.org.uk/resources/documents/project\\_reports/becta/Adult\\_Informal\\_Learning\\_educators\\_report.pdf](http://archive.futurelab.org.uk/resources/documents/project_reports/becta/Adult_Informal_Learning_educators_report.pdf)
- Illich, I. (1971). *Deschooling Society*. London: Calder and Boyars.
- International Telecommunications Union (2014) Statistics. Accessed online, 4<sup>th</sup> September 2014, at <http://www.itu.int/en/ITU-D/Statistics/Pages/stat>.
- Kim, A.J. (2000) *Community Building on the Web*, Berkeley, Ca.: Peachpit Press.
- Knowles, M. S., & Associates. (1984). *Andragogy in Action. Applying modern principles of adult education*. San Francisco: Jossey Bass.
- Kress, G. (2009) *Multimodality: A social-semiotic approach to contemporary communication*. London: Routledge.
- Lai, H-J, Wu, M-L, and Li, A-T (2011). Adults' participation in informal learning activities: Key findings from the adult education participation survey in Taiwan. *Australian Journal of Adult Learning*, 51(3), pp. 409-432.
- Laurillard (2002). *Rethinking University Teaching: A Framework for the Effective Use of Learning Technologies*, 2nd ed. London: Routledge Falmer.
- Leadbetter, C. (2005). Learning about Personalisation: how can we put the learner at the heart of the education system?. Retrieved 8<sup>th</sup> September 2014 from <http://www.demos.co.uk/files/learningaboutpersonalisation.pdf>.
- Leont'ev, A. N. (1981). The problem of activity in psychology. In Wertsch, J. V. (Ed.), *The concept of activity in soviet psychology*, 37-71. Armonk, NY: M. E. Sharpe.
- Livingstone, D.W. (2000). Exploring the Icebergs of Adult Learning: Findings of the First Canadian Survey of Informal Learning Practices. NALL (New



- Approaches to Lifelong Learning). Working Paper #10. Toronto. Available online: <http://www.oise.utoronto.ca/depts/sese/csew/nall/res/10exploring.htm>.
- Lonsdale, P., Baber, C., Sharples, M. (2004) A Context Awareness Architecture for Facilitating Mobile Learning. In J. Attewell & C. Savill-Smith (eds.) *Learning with Mobile Devices: Research and Development*. London. Learning and Skills Development Agency, pp. 79-85.
- Lonsdale, P., Baber, C., Sharples, M., Costicoglou, S., Pouliakis, A. and Mason, J. (2003) MOBIlearn Context Awareness Subsystem Specification: Literature Review, Proposed Architecture, and Pre-Prototype Demonstrator, *MOBIlearn Project Report D6.1*. University of Birmingham: MOBIlearn IST Project.
- McFarlane, A., Triggs, P., & Yee, W. C. (2009). Researching Mobile Learning: Overview. Report to Becta. Retrieved 2<sup>nd</sup> September 2014 at [http://dera.ioe.ac.uk/1473/1/becta\\_2009\\_mobilelearning\\_summary.pdf](http://dera.ioe.ac.uk/1473/1/becta_2009_mobilelearning_summary.pdf).
- Meek, S., FitzGerald, E., Priestnall, G., Sharples, M. (2013). Learning on Field Trips with Mobile Technology. In Kinuthia, W. & Marshall, S. (Eds). *On the Move: Mobile Learning for Development*. Information Age Publishing Inc., Charlotte, NC.
- Milrad, M., Wong, L.-H., Sharples, M., Hwang, G.-J., Looi, C.-K., Ogata, H. (2013). Seamless Learning: An International Perspective on Next-Generation Technology-Enhanced Learning. In Z. L. Berge & L. Y. Muilenburg (eds.) *Handbook of Mobile Learning*. New York: Routledge, pp. 95-108.
- Mocker, D.W. and Spear, G.E. (1982) Lifelong Learning: Formal, Nonformal, Informal and Self-Directed. ED 220 723 ERIC Clearinghouse on Adult, Career, and Vocational Education.
- Naismith, L., Sharples, M., & Ting, J. (2005) Evaluation of CAERUS: a context aware mobile guide. In H. van der Merwe & T. Brown, *Mobile Technology: The Future of Learning in Your Hands, mLearn 2005 Book of Abstracts*, 4th World Conference on mLearning, Cape Town, 25-28 October 2005. Cape Town: mLearn 2005, p.50.
- Palinskar, A.S. (1998). Social Constructivist Perspectives in Teaching and Learning. *Annual Review of Psychology*, 49, pp. 345-375.
- Pask, G. (1976). *Conversation Theory: Applications in Education and Epistemology*. Amsterdam and New York: Elsevier.
- Rheingold, H. (2002). *Smart mobs: the next social revolution*. Cambridge, MA: Perseus Publishing.
- Scott, B. (2001). Gordon Pask's Conversation Theory: A Domain Independent Constructivist Model of Human Knowing. *Foundations of Science*, 6(4), 343 - 360.
- Shannon, C. E., & Weaver, W. (1949). *The mathematical theory of communication*. Urbana: University of Illinois Press.
- Sharples, M. (2003). Disruptive Devices: Mobile Technology for Conversational Learning. *International Journal of Continuing Engineering Education and Lifelong Learning*, 12, 5/6, pp. 504-520.
- Sharples, M. (2003b). Imagine a future where buildings or public spaces are 'learning enabled'. Accessed 8<sup>th</sup> September 20124, from <http://www.aiuti.com/kfore/2003/02/imagining-future-where-buildings-or.html>
- Sharples, M. (ed.) (2007). *Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative*. Learning Sciences Research Institute, University of Nottingham.

- Tough, A. (1971) *The Adult's Learning Projects: A Fresh Approach to Theory and Practice in Adult Learning*. Toronto, Ontario Institute for Studies in Education.
- Vavoula, G., (2005) *A Study of Mobile Learning Practices*, Internal Report, Deliverable 4.4 for the MOBIlearn project (IST-2001-37440). Retrieved 8<sup>th</sup> September 2014 from [http://www.mobilearn.org/download/results/public\\_deliverables/MOBIlearn\\_D4.4\\_Final.pdf](http://www.mobilearn.org/download/results/public_deliverables/MOBIlearn_D4.4_Final.pdf)
- Vavoula, G.N., & Sharples, M. (2002). KLeOS: A personal, mobile, Knowledge and Learning Organisation System. In Milrad, M., Hoppe, U. Kinshuk (eds.) *Proceedings of the IEEE International Workshop on Mobile and Wireless Technologies in Education (WMTE2002)*, Aug 29-30, Vaxjo, Sweden, p. 152-156.
- von Glaserfeld, E. (1984). An introduction to radical constructivism. In P. Watzlawick (Ed.), *The invented reality* (pp. 17-40). New York: Norton.
- Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes*. Cambridge: Harvard University Press.
- Waycott, J. (2004). *The appropriation of PDAs as learning and workplace tools: an activity theory perspective. Unpublished PhD Thesis*. The Open University, UK.
- Westera, W. (2011). On the Changing Nature of Learning Context: Anticipating the Virtual Extensions of the World. *Educational Technology & Society*, 14 (2), 201–212.

### Notes:

1. The description given is adapted from: <http://www.edu.helsinki.fi/activity/pages/chatanddwr/activitysystem/> Accessed 4<sup>th</sup> September 2014.
2. This section has been informed by responses from members of the Philosophy of Technology Enhanced Learning Special Interest Group of the Kaleidoscope European Network of Excellence, in particular the commentary from Michael Young.