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Maintaining, Changing and Crossing Contexts: an Activity Theoretic Reinterpretation of Mobile Learning

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Abstract

Although mobile learning is a popular topic in current research, it is not well conceptualised. Many researchers rely on under-theorised conceptions of the topic, and those who have tried to refine the ideas involved have found this to be complex and difficult. In this paper, a new interpretation of the concept of 'mobile learning' is offered, drawing on the tradition of activity theory. The interpretation focuses on the continuity of learning activities that take place in multiple contexts which are embodied as the combination of the physical and social setting of the learning activities. The paper starts by sketching the current research context, and then outlines the theoretical tradition within which the interpretation of 'mobile learning' is located. Then, the new interpretation is offered, and the concepts are applied to case studies to illustrate how this new understanding develops current thinking in the area. The paper concludes by discussing the implications for research of adopting such a perspective.

Keywords: mobile learning; context; activity theory

Introduction

Portable devices such as personal digital assistants (PDAs), mobile phones, laptops and tablet PCs have become increasingly integrated into many facets of our daily activities, including education. The number of mobile phone owners has risen in the last few years (e.g. 75% general population in the UK, 90% young adults; Crabtree et al. 2003) and the capabilities of these devices are increasing at a steady rate.

Portables are used in education to support students' learning inside and outside the classroom (Demb et al., 2004), lifelong learning (Sharples, 2000), and location-based experiences (Price et al., 2003; Weal et al., 2003). Some educational institutes provide students and academics with portable technologies to be used for learning and

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teaching (Zelin and Baird, 2002; Demb et al., 2004; McVay et al., 2005) as these devices are believed to offer portability, accessibility and convenience (Kukulska-Hulme et al., 2005). In addition, as reported by Savill-Smith and Kent (2003) in their study on the use of palmtop computers, these devices are relatively inexpensive, provide access to information and promote the development of information literacy, collaborative learning, and independent learning, all within the context of students' learning.

Many researchers in the field are interested in empirically studying mobile learning through exploring the possibilities and constraints introduced by mobile technologies for teaching and learning in different settings. Following is a discussion of two examples of these studies. Waycott (2002) studied the possibilities and constraints introduced by PDAs that can change the activity of reading course material. She used Activity Theory to analyse PDAs as new tools for reading and to consider the context in which these devices are used. She conducted the study on a higher education online course, where students were given PDAs as a medium for reading course material. The study found the portability of PDAs as the main benefit for students' reading course materials using these devices. The devices provided access to course material anytime and anywhere, thus changing the way students undertook reading. However, the limitations of PDAs such as their small screen size and poor screen quality limited their usability for reading activities. As a result, the devices did not replace the tools students usually used to support reading; instead they were used in conjunction with printed course materials and desktop computers.

In addition, NESTA Futurelab and Hewlett-Packard Laboratories developed an educational game called 'Savannah' that helps children's learning about lions' behaviours through exploring a virtual savannah. The project aimed to 'explore how using mobile technologies in direct physical interaction with space and other players can be combined with principles of engagement and self-motivation to create a powerful and engaging learning experience' (Facer et al., 2004). The game required a group of six children to collaborate and play together; moving around the playing field, exploring the varied terrain of the savannah and discovering the resources that lions need to survive. The researchers found that the game successfully encouraged collaborative learning, and players reported enjoying the experience and learning about lions.

However, the overarching problem remains that despite the numbers of interesting studies, these have not led to a well conceptualised understanding of mobile learning. Our aim is to clarify current misconceptions and to propose a definition of mobile learning that takes an activity theoretic approach and does not suffer from the objections one may raise against the definitions in current use.

Mobile learning

Different researchers have defined the term 'mobile learning' in a variety of ways. Some focused on the mobility of the devices and hence developed techno-centric definitions. In these definitions mobile learning is characterised as learning using mobile devices such as PDAs or mobile phones. For example, Kukulska-Hulme et al. (2005) define wireless and mobile learning as 'learning delivered, enhanced or

supported mainly or solely by wireless and mobile devices and their technologies'. However, the researchers admit that the definition is limited as it places great emphasis on the technology and too little on learning. They called for a definition that focuses on the learning and the experiences of the learner. Lehner and Nösekabel (2002) share the same emphasis. They defined mobile education as 'any service or facility that supplies a learner with general electronic information and educational content that aids in the acquisition of knowledge regardless of location and time'. In addition, Sharma and Kitchens (2004) defined mobile learning as learning that is supported by mobile devices, ubiquitous communications technology, and intelligent user interfaces.

However, we believe that these definitions focus more on the technology than learning itself. In addition, they ignore learning that is not mediated by the use of portable technologies or learning that is mediated by traditional devices such as handouts even when, intuitively, this might be classified as mobile. O'Malley et al. (2003) share this emphasis (discussed below) as the researchers argued that mobile learning is any sort of learning that happens when the learner is not at a fixed, predetermined location. The definition discards the properties and type of device used to facilitate learning and focuses on the mobility of the learner rather than the mobility of the used devices. However, the researchers still argue that the employment of certain types of technology is what differentiates mobile learning from other types of learning; in spite of their theoretical position they retain their technical emphasis.

Other researchers defined mobile learning as an extension to e-learning. For example, Quinn (2000) defined mobile learning as 'elearning through mobile computational devices: Palms, Windows CE machines, even your digital cell phone'. He describes his vision of mobile learning as the intersection of mobile computing and e-learning where people have access to resources, search capabilities, rich interaction and support for effective learning and performance-based assessment. Quinn visualises mobile learning as 'elearning independent of location in time or space'. In addition, Traxler (2005) defines mobile learning as 'any educational provision where the sole or dominant technologies are handheld or palmtop devices'. He argues that the definition 'merely puts mobile learning somewhere on e-learning's spectrum of portability'. Although these definitions look at e-learning provision, they remain techno-centric as they focus on the type of device used. For example, Traxler admits that his definition is limited as it is 'rather techno-centric, not very stable and based around a set of devices'. In addition, these definitions are limited because they are based on the definition of e-learning which itself is difficult to conceptualise. That hinders identifying the unique nature of mobile learning.

When these definitions, both techno-centric and those based on e-learning, are applied to real-world examples, many borderline cases where learning cannot be defined as mobile or static appear. This is because these definitions are based on the assumption that mobile learning occurs as a result of using portable technologies to aid learning in different physical locations. The definitions are focused on the technology rather than the learning practices that are mediated by the technology. They also discard all learning that is not mediated by the use of portable technologies. In addition, the definitions place overt emphasis on the change of physical location while discarding the social setting of learning activities. This point was addressed by Roschelle (2003), who illustrated the importance of understanding the social practices involved in using

handheld devices to facilitate learning. He reviewed a number of studies that explored the use of handheld devices, such as classroom response systems and their application in classrooms. A classroom response system allows a teacher to pose a question (e.g. short-answer or multiple choices) and collects and aggregates students' responses sent by individual handheld response units. The review showed that using portable devices does not make learning mobile as the activity space of technology usage is the classroom space (Roschelle and Pea, 2002). Portable technologies in the reviewed cases were used during the class to achieve certain objectives and some could not be used outside the classroom (e.g. classroom response systems). Roschelle argues that the case studies failed to establish a link between informatics and social practices as the researchers in the reviewed studies provided little insight into the social practices of handheld use presuming that the social practices surrounding education remain largely unchanged as the technology moves from desktops to handhelds. He suggests that research attention should be directed towards 'understanding the social practices by which those new affordances become powerful educational interventions'.

Some researchers considered the emphasis of the social practices surrounding learning activities to develop their conception of mobile learning. These researchers' conceptualising of mobile learning also started as techno-centric definitions focusing on devices (Sharples et al., 2002) and the potential for enabling lifelong learning (Sharples, 2000). Soon, however, the focus became the learner, who is mobile, rather than the technology. For example, O'Malley et al. (2003) defined mobile learning as 'any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies'. In addition, Vavoula and Sharples (2002) consider learning to be mobile in three ways: 'in terms of space, i.e. it happens at the workplace, at home, and at places of leisure; it is mobile between different areas of life, i.e. it may relate to work demands, self-improvement, or leisure; and it is mobile with respect to time, i.e. it happens at different times during the day, on working days or on weekends'. These definitions diverted the focus from the technologies used to the mobility of the learner and the context of usage that extends learning to informal learning settings.

Sharples et al. (2005) are developing a theory of mobile learning that addresses the relations between mobile technology and learning. They seek to encompass both learning supported by mobile devices and learning that is characterised by the mobility of people and knowledge. They argue that in order to create a theory of mobile learning, first, mobile learning should be distinguished from other forms of leaning by showing that learners:

1. learn across space as they take ideas and learning resources gained in one location and apply or develop them in another;
2. learn across time by revisiting knowledge gained earlier in a different context which then provides lifelong learning;
3. move from topic to topic by managing a range of personal learning projects instead of following a single curriculum; and
4. move in and out of engagement with technology.

Second, Sharples et al. argue that a theory of mobile learning must embrace the considerable learning that occurs outside the classroom and lecture halls. Third, it must be based on contemporary accounts of practices that enable successful learning.

Fourth, they suggest that the theory must take account of the ubiquitous use of personal and shared technology.

Based on this, Sharples et al. proposed a definition of mobile learning that focuses on the communicative interactions between the learner and the technology to advance learning in context that is shaped by continuously negotiated dialogue between people and technology. They defined mobile learning as 'the processes of coming to know through conversations across multiple contexts amongst people and personal interactive technologies' which they described as a tentative definition. They based their definition on the Conversational Framework (Laurillard, 1993) where the conception of learning is based on the idea that communication, which is a feature of portable devices, is a central process in education as it helps people to negotiate their differences, understand each others' experiences and establish shared meaning. The definition is also based on activity theory which is used to study mobile learning in relation to the context of learning activities. They conceptualised the context of learning as both the physical environment and the community (actors of both people and interactive technologies) that interact around shared objects.

As part of developing a theory of mobile learning, Sharples et al. introduced a framework for analysing mobile learning (discussed in the Mobile learning and context section) based on Engeström's (1987) expansive activity model (discussed in the Activity Theory section). However, the framework was illustrated through a case study whose criteria were chosen from the data. Their illustration was descriptive rather than analytic as they did not test their framework against other real-world cases that do not match the framework exactly. The chosen case reflects on the four criteria proposed by the researchers as a basis for the theory of mobile learning discussed above. The case represents learning that occurs in an informal learning setting (gallery) (second criterion) where visitors were supplied with the portable technologies (fourth criterion) to be used throughout their journey in the gallery. Portables were used to look for information about the paintings in the gallery and to communicate with each other (third criterion). The case represents mobile learning as learners used their devices to learn across space, time, move from topic to topic and move in and out of engagement with technology (first criterion).

We believe that Sharples et al.'s definition of mobile learning represents a useful first step towards a better conceptualised definition of the term. The definition focuses on learning through conversations that take place across different contexts rather than locations as in some of the previous definitions of the term. Critically, Sharples et al. conceptualised context as the physical environment and the community that interacts around shared objectives. This conceptualisation helps with considering the community as being engaged in learning activities and the influence of these practices on learning. This gives a new perspective on mobile learning by considering factors, other than location, that influence it. However, Sharples et al.'s definition requires development. We believe that to understand mobile learning, there needs to be greater focus on learning practices that are directed towards the same objectives and take place across multiple contexts instead of focusing on learners' communicative interactions with peers and technology. This helps with identifying mobile learning and differentiating it from static learning.

By de-emphasising the focus on communicative interactions, we promote a definition of mobile learning that can be conceptualised using Activity Theory alone and therefore we do not require the conversational framework. The conversational framework is mainly helpful when there is a need to understand how learners develop understanding of a specific matter through conversation with others or through 'conversation' with technology; this is not the case here, as we focus on learning as practice and not as the internal development process. As a result, activity theory is sufficient as an approach to defining mobile learning as it permits studying learning practices, and is still able to account for the communications between peers and technology by treating communication as an example of an activity, that are mediated by the use of tools in relation to the context of these activities. We detail what we mean by context in a later Section. We believe that focusing on context helps with considering the setting of learning practices comprised in both the physical and social setting which are believed to be essential in understanding learning practices (Roschelle, 2003).

In conclusion, there are four definitions of mobile learning discussed here. We believe these are inadequate to study mobile learning. First, the techno-centric definitions focus more on the technology used to facilitate learning than on learning itself. Second, the extended e-learning definitions rely on the concept of e-learning which itself is difficult to conceptualise. Third, there is the definition that highlights the problem that mobility of devices does not cause mobility of learning and stresses to the importance of studying the social settings of learning activities when studying mobile learning. And fourth, there is Sharples et al.'s (2005) definition that is based on learners' communicative interactions with the technology across contexts and which we believe needs greater focus on learning practices accomplished in multiple contexts.

Given the limitations of the definitions of mobile learning, we believe that it is important to study mobile learning through focusing on learning activities that may be mediated by any kind of device (old or new), and the context of these activities including both the social and physical settings. Therefore, using an activity theoretic perspective, we propose an initial definition of mobile learning as learning that occurs as a result of pursuing learning activities that are directed towards achieving some objective in multiple contexts (physical and social). This definition enables studying real-world cases to differentiate mobile and static learning. The theoretical framework outlined below draws on key concepts of activity theory that are of particular relevance in elaborating the definition. It provides a way of looking at learning activities and the continuity of these in multiple contexts. The concept of context is also illustrated below as it represents a core concept of our conceptualisation of mobile learning.

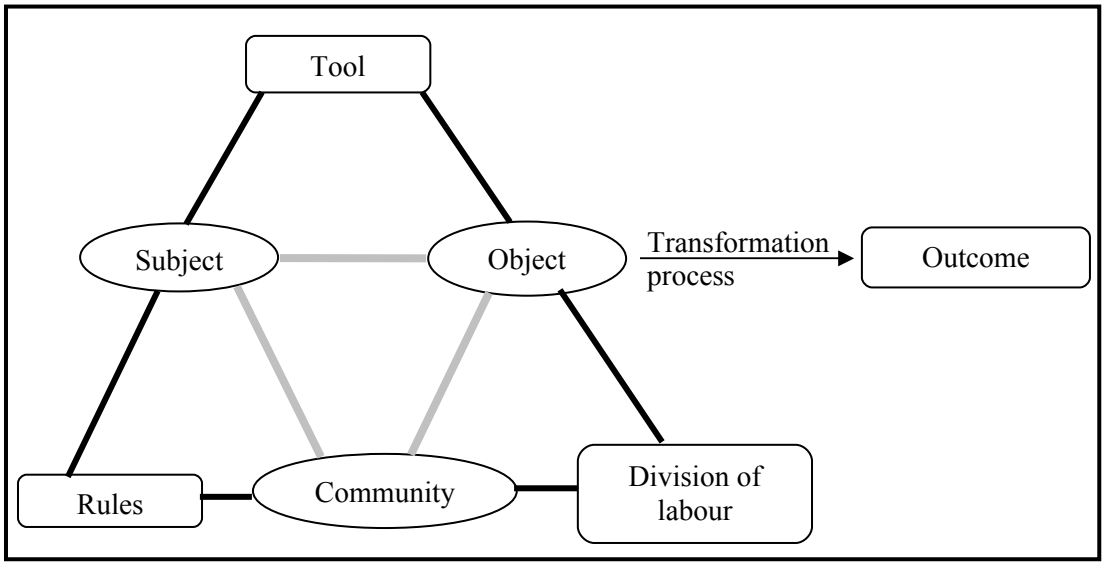
Activity theory

Activity theory was developed as an attempt to create a new form of psychology based on Marxist philosophy (Leont'ev, 1978; Vygotsky, 1978). Bannon (1997) and Kuutti (1996) demonstrated that activity theory is not actually a 'theory' in the strict interpretation of the term as it is not 'a fixed body of accurately defined statements' (Kuutti, 1996, p. 25). Rather, it consists of a set of principles that are open to

interpretation and can be used as a foundation for more specific theories. The description presented here discusses the main concepts of activity theory that are helpful in conceptualising mobile learning.

Activity theory is based on the idea that all human activities are mediated by the use of tools, both physical tools such as technology, and conceptual tools such as language that are enabling and limiting. An activity system involves a subject, whose actions are directs towards the achievement of some object through the use of tools. The object of the activity is to be understood as the 'purpose' rather than an artefact and towards which the activity is directed. The existence of an activity is motivated by transforming objects to outcomes. Engeström (1987) expanded the activity system, shown in figure 1, to include the social context of an activity represented in the community, rules and division of labour, shown in Figure 1. The community includes the people that are involved in an activity and whom share the same object. The rules cover both explicit and implicit norms, conventions and social relations within a community. The division of labour refers to the explicit and implicit organization of a community as related to the transformation process of the object into the outcome (Kuutti, 1996).

Figure 1 – Engeström's expansion of activity theory



Activity theory is used in research examining mobile learning (for example, Sharples et al. (2005)) because it provides tools for studying learners' activities that are mediated by the use of physical or conceptual tools. Therefore, from an activity theoretic perspective, mobile learning should not be defined on the basis of the type of device used as in some of the definitions of the term as this type of learning can be mediated by any type of physical tools (old or new) or conceptual tools (symbolic or embodied) tools. Activity theory also provides an historical perspective on learning activities. This facilitates studying mobile learning by showing the continuity of learning activities that are directed towards the same objective in different contexts. Nardi (1996) argues that activities and their elements are in continuous development. In addition, the remains of previous activities are usually embedded in them as they develop which requires historical analysis to understand the recent situation. Activity theory also places great emphasis on the relationship between context and humans'

activities. Cole and Engeström (1991) suggest that in order to understand humans' activities it is crucial to understand how artefacts (such as tools and symbol systems) mediate the activity within the cultural context in which the activity is situated. In terms of studying mobile learning, studying context helps with understanding and considering the properties and constraints of the environment where learning take place and the impact of the relations among individuals, artefacts, and social groups within that on learning activities.

Context

Understanding humans' activities requires understanding them within their context (Cole et al., 1991). The concept of 'context' has been a source of endless confusion for Anglo-American psychologists. Over the last decade, psychologists have come to distinguish between two general uses of the word. For example, Cole (1996) distinguishes between context as 'that which surrounds us' and context as 'that which weaves together'. In terms of the interactions between humans and technology, these definitions map context as that which surrounds the human user of the technology and context as that which arises from the constructive interaction between people and technology.

The context that surrounds the human user of the technology is roughly equivalent to the term 'environment', and refers to a set of circumstances with which the individual interacts and which influences individuals in various ways (Cole, 2003). This is often represented as a set of concentric circles representing the different levels of context. For example, a student using technology is part of a lesson that is part of a classroom that is part of a university that is part of a community (Cole, 1996). Understanding activities in relation to the environment where these take place helps with understanding how the task is shaped by the broader levels of context. In terms of the impact of context on learning activities, Sharples (2005) refers to the informational model of communication developed by Shannon-Weaver. The model states that the context that surrounds the human user of the technology situates the learner in an environment from which the senses continually receive data that are interpreted as meaningful information and employed to construct understanding.

The context that arises from the constructive interaction between people and technology can be thought of as two moments in a single process that help in modifying objects to create supportive workspaces, or forming ad hoc social networks out of people with shared interests (Cole, 1996). This definition of context is more focused on the social setting of the learning activities which not only affects learning activities, but is also affected by these activities. Vygotsky views context in this way, seeing humans as an embedded part of the social matrix so that their behaviour cannot be understood independently of this matrix (Cole, 2003).

The complexity of understanding context has started to feature in research on the design of technology. For example, Dourish (2004) argues that 'context' plays a central role in ubiquitous computing where computing is embedded into the world around us. He suggests that as computation has moved 'off the desk', it is important to keep track of where it has gone as the situations in which the technology is used became more variable and require further attention.

Dourish argues that since 'context' entered the area of computational design, designers have hoped that incorporating context into interactive technologies can make these technologies more sensitive to the details of specific setting of use. He reports Suchman's (1987) critique that social scientists have often pointed out that conventional system designs fail to respond to the setting in which action unfolds. These conventional systems may be more responsive to the different social settings in which they might be used, but they fail to address the sociological critique which makes turning social observations into technical design problematic.

Dourish suggests that the notion of context in ubiquitous computing has a dual origin. First, from a technical notion, he argues that in much current ubiquitous computing research the idea of context is that it consists of a set of features of the environment surrounding generic activities, and that these features can be encoded and made available to a software system alongside an encoding of the activity itself. In addition, drawing from social science, context focuses analytic attention on certain aspects of social settings such as, focuses on 'how and why, in the course of their interactions, do people achieve and maintain a mutual understanding of the context for their actions?'

In conclusion, current conceptions of context, both in social and technological research, view it in terms of the features of the environment where learning takes place and the social setting of the learning activities. We believe that for the definition of mobile learning, both conceptions of context should be considered because this type of learning occurs as a result of pursuing learning activities across multiple locations. This helps with considering the factors that affect and are affected by the utilisation of portable devices in multiple contexts such as the impact of the changes in the physical environment and the social setting within these environments on learning activities. As discussed earlier, Sharples et al. (2005) also consider both conceptions for the definition of mobile learning. However, what differentiates our approach is the way we understand the interplay between the physical and the social conceptions of context and the way social context is conceptualised through activity theory. This is further discussed below.

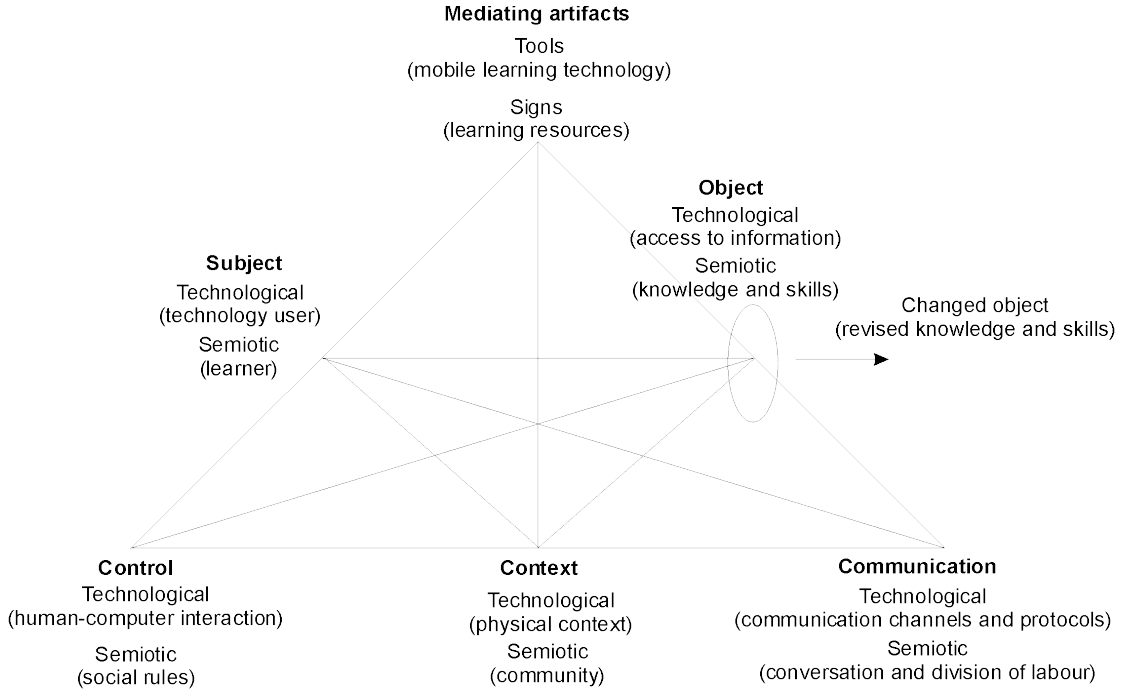
Mobile learning and context

Understanding learners' activities in relation to context is important for studying mobile learning as this type of learning occurs when learning activities are mediated by the use of tools (physical or conceptual) across different context. Therefore, we take context-crossing as the basis for our conceptualisation of mobile learning through activity theory. From an activity theoretic perspective, we consider context as a mixture of the physical features and constraints of the location where learning activities take place and the social features of these activities such as the social relations, norms, conventions, and the division of labour within the learners' community.

Existing interpretations of activity theory for mobile learning

Activity theory has been used as a framework for studying mobile learning because it provides a framework for studying activities that are mediated by the use of tools and accounts for the context of these activities. For example, Sharples et al. (2005) attempted to describe the activity system of mobile learning through the use of Engeström's (1987) expansion of activity theory by describing the relationship between people and technology. They used activity theory in combination with the conversational framework to indicate the importance of conversation and context in understanding mobile learning. Based on that, they developed a two-layered version of Engeström's expansion of the activity system triangle. They argue that it is helpful to separate two layers of tool-mediated activities in order to analyse the activity of mobile learning. First, the semiotic layer describes learning as a semiotic system where learners' object-oriented actions are mediated by cultural tools and signs. The learner internalises public language that is instantiated in writing and conversation which then provides the resource for the control and development of activity (Vygotsky, 1978). Second, the technological layer represents learning as an engagement with technology where tools, such as computers and mobile phones, are used as interactive agents in the process of coming to know. This layer creates a human-technology system to mediate agreements between learners (e.g. spreadsheets and concept maps), and aid recall and reflection (e.g. online discussion lists). The researchers suggest that these two layers should not be separated from each other, nor be superimposed; they should be put in a continual dynamic where they can be moved together and apart, creating an engine that drives forward the analysis of mobile learning. Figure 2 shows Sharples et al.'s framework for analysing mobile learning.

Figure 2 - Framework for analysing mobile learning (Adapted from Sharples et al. (2005))



However, we believe that this framework is complicated because of introducing two layers to represent the semiotic and technological layers of an activity. We suggest that there is no need for these layers as what concerns us when studying mobile

learning is the learning activities that are mediated by the use of tools (physical or conceptual) in relation to the context of use (physical and social). Engeström's expansion of activity theory is sufficient for this as it has the ability to represent human activities (including the semiotic and technological elements of such systems) in relation to their context eliminating the complexity introduced by the two layers proposed by Sharples at al.'s framework. Therefore, our conceptualisation of mobile learning will be based on Engeström's expansion of activity theory as it provides a framework for studying learning activities that are mediated by any kind of tool (old or new, embodied or symbolic), and how these practices vary across physical location, and considers the social context of learning activities through the 'rules', 'community' and the 'division of labour'. This makes analysing the activity system of mobile learning simpler by focusing on the collective context embodied in the physical and social setting of learning activities.

Application

To illustrate our conception of mobile learning, we draw upon our experience of an ongoing project in higher education. Three studies were conducted on higher education students that use both portable and conventional devices to aid their learning practices. The aim of the studies was to investigate the impact of utilising portable technologies on students' learning practices. The data was mainly collected through observations of students in both formal and informal settings. Data was also gathered through log files that were collected from students' laptops and showed the activities students pursued using their laptops. Log files were specifically helpful with providing information about students' utilisation of portables in setting where students could not be observed such as at home. The observations and log files helped with looking at the continuity of students' learning in formal and informal settings which aided studying mobile learning.

The collected data were searched for cases that represent mobile and static learning based on the idea of context-crossing discussed earlier. Context, as illustrated by Cole (1996) and Dourish (2004), can be the physical features of the environment where learning takes place, or the social setting of learning activities. We considered both conceptions through Engeström's expansion of activity theory. A change in the physical context was interpreted as a change in the location where learning activities take place which also determined whether learning is mobile or static. A change in the social context was interpreted as a change in the rules and the division of labour that govern the students' community which shares the same objective. The tables below list some examples that show how these are related back to the two positions of context discussed above thus illustrate our categorisation of learning based on context-crossing. Table 1 shows two examples of mobile learning, the examples are adapted from the studies we carried out. Table 2 shows two example of static learning that are extracted from our studies as well. The cases are analysed based on the two perspectives on context discussed above. This helps with determining the extent these perspective help with the definition of mobile learning and what they reveal about mobile learning that the current definitions did not.

Table 1 – Examples of mobile learning

Mobile learning	Context as physical location	Context as social setting
Case 1: The log files collected from a student's laptop showed that the student used her laptop to view lecture slides and take notes in the classroom, revise the slides, look for information on the web and write more notes on the slides at home, and then use the slides again to facilitate group discussion during a group meeting that took place the next day.	Students' learning in this case is considered mobile as the student continued using her laptop and working towards achieving the learning objective (develop her understanding of a topic) in different locations (classroom and home).	The social setting changes as a result of a change in the rules, division of labour and the community that the student belongs to. **Rules:** *Classroom:* Read from the lecture slides through the laptop and take notes *Home:* Read through the lecture slides using the laptop, search the web for more information, and take more notes **Division of labour:** *Classroom:* Students/ Instructor *Home:* Student **Community:** *Classroom:* Students and instructor *Home:* Student These changes in the social setting happen as a result of a change in the physical location and a development in the activity that the student is engaged in.
Case 2: A student in hospital placement uses the same handout to follow the instructor's discussion, take notes and practice diagnosing a patient in three different tutorial sessions that took place in three different tutorial rooms during three days.	The student's learning in this case is considered mobile as the student used his handout in three different tutorial rooms to achieve an objective (develop his understanding of a topic).	In this case, the student used the printed material to achieve the same objective in three different physical locations. Thus the **rules** (Read from the handout, listen to the instructor's illustration, take notes and practice on a patient) and the **division of labour** (Students/ Instructor) of the students' **community** (Students, instructor and a patient) did not change throughout the activity.

Table 2 – Examples of static learning

Static learning	Context as physical location	Context as social setting
Case 3: An instructor changes the way lectures are usually delivered which is based on illustration through slides and then asking students to write an essay posted on the VLE (Virtual Learning Environment) at home in relation to the discussed topic and the instructor corrects that in her free time and posts students' grades online. The observed lecture was arranged to include all the above practices as the instructor started the lecture by illustrating a topic using some lecture slides downloaded from the VLE and then asked students to apply what they have learnt in the class by writing an essay about a topic that is posted on the VLE using their laptops. The instructor then corrected the essay for each student and gave them their grade during the lecture.	In this case the students' learning is considered static as students achieved the learning objective (develop their understanding of a topic) of the activity while they are still in the same location (classroom).	The social context of the lecture observed has changed in comparison to the previous lectures because of changes in the rules and the division of labour of the student's community. **Rules**: *Previous lectures:* View lecture slides and take notes using the laptop *Observed lecture:* View lecture slides, take notes using the laptop, write and essay using the laptop, and check the essay with the instructor **Division of labour:** *Previous lectures:* Students/Instructor *Observed lecture:* Students/Instructor **Community:** *Previous lectures:* Students and instructor *Observed lecture:* Students and instructor Changes in the social context occur as a result of the differences introduced to the format of the lecture. For example, the social context of the activity where the student is following the instructor's illustration and taking notes differs from that where the student is writing an essay in class. This difference can be seen in both the rules that apply and the division of labour. **Rules:** *During illustration:* view lecture slides and take notes *During essay writing:* read the essay question and write the essay using the laptop **Division of labour:** *During illustration:* Students/Instructor *During essay writing:* Student **Community:** *During illustration:* Students and instructor *During essay writing:* Student
Case 4: A student uses his mobile phone while being in the library to capture a photo for an image in a book and transfer the photo to his laptop.	The student's learning is considered static as the student achieved the objective (capture a photo of an image in a book) of the activity while being in the same location (library).	The social context of the activity did not change as the **rules** (Capture a photo and transfer it to the laptop) and **division of labour** (Students) of the student's **community** (Students) did not change throughout the activity.

The tables showed that context-crossing can be used as a basis for studying mobile learning and differentiating it from static learning. Learning in the cases was

considered mobile when a change occurred in context as physical location. In these cases, learning activities that are directed towards the same objective were pursued in different physical locations over time. In addition, the tables showed that static learning occur when the objective of learning activities is achieved while the learner is still in the same location. Therefore, using context as the physical location helped with differentiating mobile and static learning. The tables also showed that in some cases of mobile and static learning, changes occur in the social context as a result of a change in the physical location or a change in the activity pursued. In these cases, students' learning is more socially interesting than the cases where the social context is unchanged. Therefore, using context as the social setting of learning activities helped with showing what is interesting about mobile learning.

The tables showed that using context-crossing as a basis for defining mobile learning gives a different perspective on the term as it illustrates the relationship between contexts, physical and social, and learning practices. The tables can represent both the technological layer as well as the semiotic layer which were proposed by Sharples et al. without the need for complex overlapping activity systems or the conversational framework. However the question remains, which of the above cases can be argued to represent 'real' mobile learning? Is it the case where context was represented as a change in both the physical and social contexts? Or any case where mobile learning was classified as a result of a change in the physical context alone? We believe that what is interesting for research are the cases where context crossing is represented as a change in both the physical and social contexts. This shows that there is more about mobile learning than pursuing learning activities across multiple physical locations.

Discussion

The current definitions of mobile learning are limited when used to analyse real-world case studies. For example, some of these definitions are based on the assumption that learning is mediated by portable technologies which are used in different physical locations (location crossing). However, the studies showed that learners not only use portable technologies, as conventionally studied in research (e.g. PDAs, laptops), to aid their learning activities, they also use conventional devices such as handouts and textbooks. This challenges the general understanding that traditional learning is static learning because learners use traditional devices to aid their learning which usually takes place in the same classroom. Much traditional learning can be considered mobile because learners use conventional devices in the same manner as using portable technologies to pursue learning activities across different contexts such as at home or in the library. Therefore, the definition of mobile learning should cover conventional devices as well as any other technology. It should also consider learning that is mediated by conceptual tools as learners engage in different activities that aid their learning and may/may not use any physical devices to aid that learning. For example, a student uses his laptop to view lecture slides in the classroom, revise these at home, and then practice what he had learned in the laboratory to conduct an experiment. In this case, although the student is not using any type of device to aid his learning in the laboratory, he is undertaking an activity that aims at achieving the same objective, developing his understanding of a topic, as the activities pursued in the classroom and home through a laptop. Therefore, learning in this case is considered mobile because the student pursued learning activities that are directed

towards the same objective in different contexts, even if the student did not use a portable device to aid learning. Moreover, the definition of mobile learning should consider learning that continues to take place in the same location but over time as in traditional education where lectures usually take place in the same classroom during the academic year. In these cases, learning that is aimed towards the same objective may continue in different contexts in between.

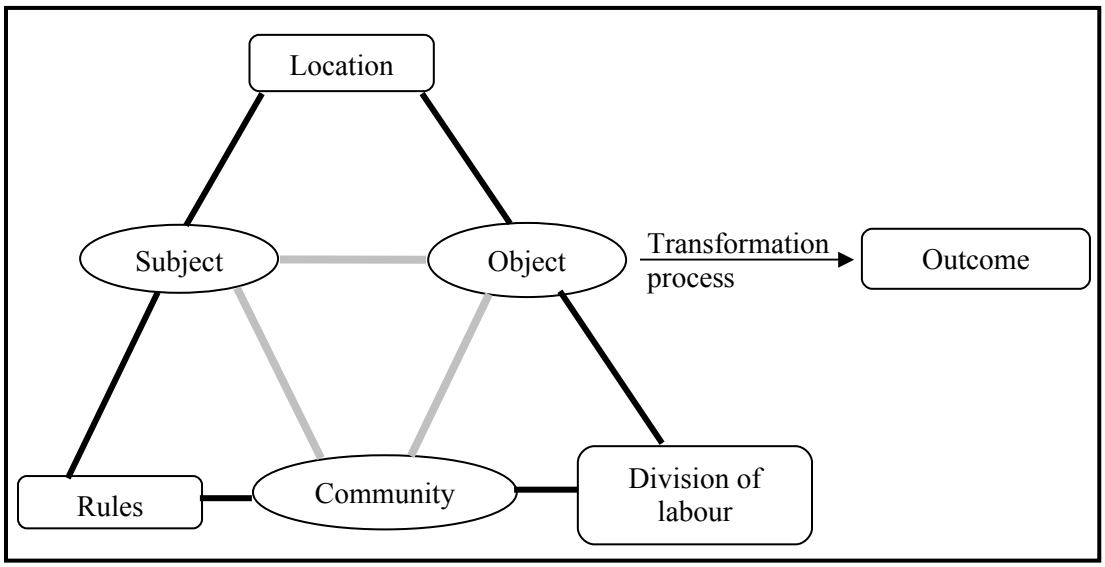
In addition, some uses of portable devices are effectively static as the objective of the learning activities is achieved while the learner is in the same location. For example, if a mobile phone's calculator feature is used in lecture theatres to help solving mathematical problems, the usage of the device is static as the learning objective is achieved while the learner is still in the same location. In such cases learners are maintaining context and not crossing it.

Defining mobile learning based on location crossing has not been useful as this puts great emphasis on the location where learning activities take place and discards all other factors that affect these activities such as the social setting. Therefore, we base our conception of mobile learning on the idea of context-crossing. However, defining mobile leaning based on context crossing has also not been helpful historically as the definition of context itself is ambiguous. Cole (1996) and Dourish (2004) defined context as (a) what is constructed through the interactions between learners and technology, or (b) what surrounds the human user of the technology. The conception of context in the first definition is misleading when used to define mobile learning by itself because the interactions between the learner and the technology can be constructed and changed even if the learner is physically static. This is also a problem for activity theory. From an activity theoretic perspective, context changes as a result of a change in the social setting of the learner, represented as the community, rules and the division of labour in an activity system. This implies that all learning where the social setting changes is defined as mobile learning even if the learner is physically static. For instance, the community that the learner is part of changes when someone comes into the lecture room where the learner is located; but arguably, this is not something we would want to classify as mobile learning. Therefore, the first definition of context is not sufficient for supporting our definition of mobile learning. In the second definition, context is represented as the location where the learner is and how the properties and constraints of that location affect the learning activities. Context crossing here implies location crossing as context changes for each location. Therefore, the second definition of context is sufficient for defining mobile learning based on the idea of context-crossing but it discards the social context of the learning activities which help with studying what is interesting about mobile learning. For instance, if this conception is applied to Case 1 that is illustrated in Table 1, learning is defined as mobile because the learner pursued learning activities across locations. However, there will be no indication of the changes in the social context that occur as a result of using the technology, which if represented shows what makes using portable devices for learning fun and socially interesting. Therefore, what makes learning activities socially interesting is for the social context to develop in some way.

The above discussion shows that neither concept of context-crossing alone is a good basis for researching mobile learning. It is apparent that what actually interests us is the intersection of these definitions, where mobility happens as a result of location crossing and at the same time changes in the social context make mobile learning

socially interesting. Based on that, we view context as the combination of the physical location, including the properties and the constraints of that setting, and the rules and the division of labour governing the learners' community. The activity system triangle below shows our representation of mobile learning based on the idea of context-crossing where location is represented in the activity system as the tool that enables mobile learning. Therefore, mobility happens when the subject and object are preserved, but the location (conceived as a tool and including any available devices) is changed. Under this reformation, the social context which is presented in the rules, community and division of labour of the activity system may or may not change. The situation becomes interesting, socially, when the bottom half of the activity theory triangle also changes. In contrast, Sharples et al. representation of context in the activity system of mobile learning was done through the 'community' component alone which was argued to represent both the physical environment and the community of actors (people and interactive technology) who interact around shared objectives.

Figure 3 – Framework for analysing mobile learning



Summarising these discussions, we propose that the table below (Table 3) can be used to distinguish mobile and static learning. It also distinguishes between socially interesting mobile and static learning. The table is based on the conception that mobile learning can be defined in relation to the concept of context-crossing where context is the conjunction of the location where the learning activity is taking place and the social setting, represented as the rules and the division of labour of the community that the learner belongs to. In this table, the intersection between context as a change in location and context as a change in social settings helps with identifying socially interesting mobile learning. However, it should be noted that as a consequence of activity theory's historical perspective, we must recognise that what makes mobile learning socially interesting may dwindle over time, in which case learning that was interesting may become ordinary. Learning will still either be mobile or not; the historical aspect only affects one of the two dimensions when analysing a case.

Table 3 – Illustration of context crossing as a basis for defining mobile and static learning

		Context as social setting	
		Conventional	Social setting changing
Context as physical environment	Location crossing	Mobile learning *(e.g. Lecture being moved to seminar room)*	Socially interesting mobile learning *(e.g. Dispersed discussions during fieldwork)*
	Static	Static learning *(e.g. Lecture)*	Socially interesting static learning *(e.g. Innovative lecturing (new teaching))*

Based on our conception of context-crossing illustrated in Table 3, mobile learning can be defined as learning that occurs as a result of pursuing learning activities that are directed towards achieving the same objective across multiple contexts (both physical and social).

Conclusions

The current definitions of mobile learning are problematic as they are focused on learning that is mediated by certain mobile technologies. Rethinking mobile learning in terms of context crossing gives a new perspective on the term by shifting the focus from the technology used to the context of use. However, the current uses of context for defining mobile learning are ambiguous and unhelpful. This paper clarifies 'context' from an activity theory perspective as a combination of the properties of the physical location where the learning activity is taking place and the rules and the division of labour within the community that the learner belongs to. This conceptualisation helped with proposing a definition of mobile learning that does not focus on the utilisation of mobile technology, but on the forms of people practices involving any technology, old or new, and how these practices vary across contexts which are embodied in the combination of physical and social setting of learning activities. The definition showed that it is not the technology that makes learning mobile, but the continuity of learning activities in different contexts (physical and social). The definition also helped with differentiating mobile learning from static learning which was a weakness of the previous definitions of the term.

We propose that future studies look at mobile learning in terms of learning activities taking place across contexts (represented as both physical and social), placing more emphasis on the relationship between learning activities and social context which has shown to affect and be affected by learning practices. This also helps with studying what differentiates learning that is mediated by the use of portable technologies from learning that is mediated by the use of other conventional devices. For example, learning through portable technologies is not only affected by the social context of learning activities, but also helps to create contexts that conventional devices can not create and thus helps with creating new learning experiences. However, these experiences become routine over time. Future studies should also focus more on studying learning that continues to occur in the same location over time such as

classrooms. These cases can clarify the relationship between learning activities and the social context that occurs in the same physical context.

References