Mobile Learning in School Contexts: Can Teachers Alone Make It Happen?

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Abstract—Evidence from a range of studies indicates the potential that mobile technologies have to support important aspects of learning. However, it is clear from a number of study findings offering evidence about implementation approaches that developing relevant uses of mobile technologies to support learning is not concerned just with appropriateness of learner techniques or pedagogical approaches, but also with developing wider cultural acceptance and involvement in the contexts in which learning is supported. This paper will present an argument that implementing activities involving mobile technologies that offer benefits to learning requires an adoption of approaches and factors at a wide systemic level. Learning activities using mobile technologies can (and should) occur within learning settings that constitute the foundation of a wide system, including both home and school (informal to formal) elements. An implementation framework is proposed that accommodates appropriate practices within this wide context. It highlights the need for cultural and political factors to be involved at earlier as well as later implementation stages if wide success is to be accomplished.

Index Terms—Mobile and personal devices, nomadic learning environments, social networking, social learning techniques, implementation.

1 Introduction

Teachers in a number of schools (elementary, primary, secondary, and high schools) are introducing mobile learning technologies so that pupils might benefit from the features they offer. In this paper, I will explore key features and factors that need to be considered by managers and practitioners if they are to implement mobile learning technology into schools successfully. Some of these features and factors lie outside the immediate realms of teacher classroom practice, but do need to be accommodated. I will propose a systemic implementation framework, modified from an existing framework, to model these features and factors. The constructs at the heart of this framework take up a salient point made by Roschelle [1], who noted that certain features of mobile devices would almost certainly be fundamentally important in terms of supporting learning, but that taking an oversimplistic view of the roles and social practices involved could well diminish outcomes.

To identify a framework to appropriately describe and model successful implementation of mobile learning technologies, I will consider evidence from a number of relevant areas of study. Initially, I will summarize what a number of published studies and reports say about implementation and the aspects of learning activities that are being supported. It will be clear that these learning activities could involve stakeholders beyond the immediate boundaries of the classroom, but at the same time, offer important learning opportunities.

A range of research literatures on the development of learning highlights reasons why these activities are fundamentally important to pupils' education and learning development, and that they rely upon certain operational features of mobile learning technologies. I will select examples of such learning activities and show that for implementation of these activities, practitioners and managers need to adopt a systemic approach involving important cultural and political elements from the outset.

I will review a number of models describing the adoption and implementation of technologies (including mobile learning technologies) into schools to consider a framework that can adequately describe features and factors involved in the successful integration into practice of these forms of learning activities. A selected framework will need to accommodate technologies providing access and opportunities for learning in settings inside as well as outside school, with mobility offering learning interactions at times and in places selected by the learner or others involved in learning support.

I will use evidence from two specific case studies exploring school, home, informal, and formal uses of mobile handheld technologies by pupils in school and community localities to show how the proposed implementation framework describes and explains acceptance and adoption of mobile learning practices in terms of learning outcomes, impacts, and involvement with stakeholders.

In arguing that the introduction of mobile technologies into schools needs to be considered fundamentally from a change and systemic implementation perspective rather than from a more simplistic phased implementation perspective, I will identify, in summary, the factors affecting implementation for each stakeholder.

2 Mobile Technologies and Learning

Evidence, both from a range of published studies (Perry [2], Naismith et al. [3], Attewell [4], McFarlane et al. [5], Lai et al. [6]) and from findings of studies carried out by the

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author (reported later in this paper as case studies), indicates that certain learner activities are being supported effectively and positively through features of mobile technologies. Mobility, coupled with ease of software access and integration of media and applications, allows pupils to work more continuously across home and school settings, allows activities to be initiated outside the school, or practice on exercises to be undertaken when or where desired (vocabulary exercises on a Saturday afternoon in a car, for example). From a cognitive learning perspective, it is clear that current mobile technologies grasp the attention of many pupils; pupils engage in acquisition of knowledge through a range of sensory (visual, auditory, kinesthetic) routes (reported by Perry [2], Naismith et al. [3], Attewell [4], and McFarlane et al. [5]). Some researchers have reported impacts on learning in specific cognitive areas, enhancing the manipulation of ideas and knowledge, rather than supporting the earlier engagement and acquisition stages of cognition. Lai et al. [6], for example, looking at learning outcomes in 2 fifth-grade classes in an elementary school found improvements in knowledge creation during experiential learning. Evidence across the studies of Perry [2], Attewell [4], and McFarlane et al. [5] shows that pupils can retain certain knowledge and skills when using mobile technology facilities, they are able to rehearse knowledge, and to recall it through a range of routes (supported, it appears, through high personal levels of ownership and modes of use). What is clear from these outcomes is that the form of learning activity and the provision of ownership make a difference to outcome. This being the case, implementation frameworks need to focus centrally on appropriate learning activities; there is an important role in schools for both the teacher and manager to know about learning activities that will support the learner, allow for opportunities to extend and engage learning outside the classroom as well as inside the classroom, and enable the learner to gain as full an ownership of the mobile technology for learning as possible.

While teachers supporting learners with mobile technologies do so in different ways, some teachers conceive or provide activities that focus on engagement, acquisition, and rehearsal of knowledge or ideas (such as a resource to check spellings using audio as well as text facilities [7]). Others focus on internal higher order cognitive aspects such as analysis or synthesis or evaluation of ideas (identifying what a video of a science experiment tells you when you see a set of chemical reactions, for example). Yet others focus on the externalization of ideas (bringing together images and notes from a visit to a castle to create a news story report, for example). Teachers choose learning activities to match the needs and starting positions of their learners, as well as meeting curriculum needs. Using research evidence about learning and its development, implementation of learning activities using mobile technologies should certainly consider whether there are opportunities for learners to gain from aspects provided that are critical to effective learning. These critical aspects include metacognitive elements of learning, such as the reflective characteristics and thinking strategies described by Presseisen [8] or Moseley et al. [9], and megacognitive aspects of learning, such as the importance of conversation, discussion, and talk described by Pask [10], or the importance of social contexts in developing cognition described by Vygotsky [11], or the importance of "big pictures," or the transfer of learning described by Bransford et al. [12]. To offer activities that support these critical features of learning, teachers might select to use mobile technologies in certain ways. Rather than to just undertake communication itself, learning activities selected might include those concerned with data capture, exchange and sharing, or those sharing imagery, ideas, and thoughts to provoke discussion ("offline" as well as "online," exemplified in the practice described in a case study published by Steljes, for example, [13]).

3 Useful Learning Activities

From a teacher practitioner viewpoint, selected activities can benefit from mobile technology features, and at the same time, support a range of learning elements. "Review and reflect," where pupils capture audio, imagery, and video during lessons, used in plenary sessions to reflect on what has been covered, the key elements learned, how these fit into wider pictures, and how ideas might be taken further outside the classroom, can support higher cognitive and metacognitive levels of learning. "Think forward," where pupils access future topics via the Internet and capture relevant thoughts or ideas to contribute to these in class or through online discussions, can support aspects of the transfer of learning. "Listen to my explanations," where pupils record audio to complete homework assignments and teachers mark these verbal explanations, can support active engagement and reflection. "Snap and show," where pupils capture imagery that is downloaded, for wider pupil discussion, made accessible to parents so that they can see and discuss events that have happened in school, can support enhanced participation. "This is what I've done and how I've done it," where pupils create presentations of how they have used mobile technologies to tackle particular activities, these are recorded and made accessible on appropriate Websites for teachers and parents to see, can support enhanced social interactions. "Tell me how I could improve this," where pupils share their work in multimedia formats with peers, mentors, teachers, or trusted adults in order to seek evaluative feedback, assessments of their work, and ideas for improvement on which they can act, can support the development of supportive social networks. It can be argued that it is these forms of activity that need to be developed and exploited more, if mobile technologies are to feature strongly in providing support for learning in ways that other technologies cannot provide. Mobile technologies allow ideas or examples to be captured at a point in time when and in a place where these are generated or observed, they allow conversation and discussion at times when and in places where points of interest arise, and they allow sharing of captured or saved work items in places where people with more information or other perspectives are found.

Mobile learning technologies support these forms of activities in a range of ways. They offer immediacy of "snap and show" actions, and access to resources where and when required (when a learner is in a gallery or garden, for

example). Records go wherever the learner is, to share these where and when they choose, in locations that can be remote from desktop or fixed equipment. They offer ease and relative unobtrusiveness of use in classrooms, as well as integration of records with other software facilities, providing a width of media to allow changes to be made at a point of discussion. They offer accessibility through other devices for wider presentation purposes inside and outside a classroom. From across this list, it is clear that learning activities focusing on critical aspects of learning, involving conversational, social, and societal aspects can be selected by teachers and used in practice. However, although it is likely to be within this realm that mobile technologies could have the widest and most profound impacts, it is also clear that while teachers can set up these activities, learners depend on the willingness and acceptance of other stakeholders to undertake them in their entirety. This being the case, implementation models or frameworks need to consider not only who these other stakeholders might be, and what their roles are or might be, but also how these other stakeholders will be involved in engaging with and supporting these forms of learning activities (and these forms will be identified within the case studies described in Sections 5 and 6). If these types of learning activities are to be undertaken effectively, involving stakeholders outside the school as well as inside the school, then implementation will need to accommodate both an acceptance of mobile technologies as devices that are useful and important to learning, and an acceptance of stakeholder roles when involved in a learning activity itself, together with development of appropriate involvement practices.

4 Implementing Mobile Technologies: Theories and Constructs

In considering models and frameworks that will adequately describe and support mobile technology implementation, a starting point is to consider a number of existing theories and frameworks that have described and modeled technology adoption in schools. Hord et al. [14] proposed a framework that has been summarized in the Concerns-Based Adoption Model (CBAM) [15]. This model describes staged approaches to implementation at the level of the individual, where the individual moves through stages of concern. These stages of concern move from level 0 (awareness) to level 6 (refocusing). But, for any technology implementation, what is important is to know what it is that helps to move someone from one stage to another. For mobile technology implementation, what moves an individual from a stage 0 (awareness—"I am not concerned about it") to stage 1 (informational—"I would like to know more about it") is fundamental to successful engagement and practice. Across the stages, concerns move from "the self," to "the task," and ultimately to "the impact." However, while the CBAM framework offers features that are of value in terms of the implementation of key learning activities, its shortcomings are concerned with its focus on the individual, rather than on ranges of stakeholders working in a related rather than in individual ways, and its lack of initial focus on acceptances of technologies and involvement with them. Concerns clearly have a major role to play within any implementation framework selected for mobile technologies, but initial engagement and involvement of a range of stakeholders is a fundamentally important requisite that must be accommodated.

In terms of thinking more specifically about moving forward with implementation, Waycott [16] proposes a Tool Integration Process (TIP) model that considers and accommodates both constraints and possibilities of how to use technologies as ways of mediating and developing new operations with new tools. Waycott includes community as an element to consider within the Activity System Tool Appropriation Model (ASTAM), but this element is discussed in terms of the immediacy of impact of community on the tasks being undertaken. The model does not easily accommodate implementation of mobile learning technologies within school and home settings, which requires a concern for mediation and development of new operations within different, but maybe related settings.

Thinking about those involved in implementation, Rogers [17] identified different ways and times when different individuals might be involved in implementation. He proposed a model that considered implementation from a user perspective with different approaches to implementation being labeled, such as "innovators" and "early adopters." Although interpreted more from a teacher than from a pupil perspective, the model does implicitly suggest, perhaps, the important roles of interest, endeavor, and potential value that might be involved when individuals approach implementation. So, while Waycott [16] highlights the importance of constraints and opportunities of use, Rogers [17] highlights the importance of individual interest, endeavor, and enterprise factors (and arguably teachers might be more concerned with these factors). The weakness of this model for mobile learning technology implementation, however, is its reliance on observation of practice, rather than providing a framework that offers intervention opportunities through which to develop appropriate practice.

Davis' earlier Technology Acceptance Model (TAM) [18] discusses the importance of technological usability and usefulness, so focuses more on the importance of a technology as a tool (or set of tools). Engestrom [19] discusses the importance of rules and regulations in implementation, which implies the need to consider wider societal factors, such as legitimacy of activity. Engestrom's Activity Theory also introduces the important concept of division of labor, which is important when considering implementations that include multiple stakeholders providing contributory involvement to a wider picture. However, for the purposes of learning implementation led by schools, the theory does not provide an easy structure through which important elements would be recognized or handled by managers or teachers in the schools.

Some implementation models have indicated the importance of stages, phases, or a series of steps, often concerned with identifying early focal activities, and moving toward activities set in wider contexts. Hooper and Rieber [20] proposed a five-step model, which moved from familiarization (awareness) to replication (utilization and development) to integration (optimization) to modification (reorientation

and pioneering), and finally, to transformation (evolution). This model, which focuses on concepts of institutional implementation as much as individual implementation, echoes the stages proposed in the CBAM construct. Those implementing new technologies, taking concepts within the Hooper and Rieber model, face the need to consider not only the factors and needs of individuals during implementation practices, but also wider perspectives concerned with institutional implementation. While schools often use phased implementation frameworks, and those external to schools in agencies such as local authorities or regional support units often propose them, these frameworks focus on activity within the school, rather than highlighting the need to consider a wider systemic view from the outset. Within phased frameworks, challenges of implementation of new technologies need to accommodate specific factors such as the impact dip, as discussed by Fullan [21], explored in the context of technology implementation by Mevarech [22], and described and illustrated as a U-curve with downward impact prior to increased positive impact. This concept indicates that implementation of new activities may well lead after an initial phase to a dip in impact; if impacts are measured at that time, and impacts are recognized by key stakeholders to have shifted negatively, then the longer term more positive impacts may well not arise if implementation is foreshortened. Commitment of a longer term nature, as well as a shorter term nature, is therefore potentially important for successful implementation. However, no specific dips in impact have been measured and identified through studies looking at implementation of mobile technologies, and this may be due to the short period of time taken to move from operational use to application to learning.

Corbett and Rossman [23] have argued that less direct or explicit factors, which lie beyond the immediacy of the classroom or school itself, are also fundamentally important for successful implementation of activity. They argued that there were three paths that implementation might follow: a technical path (focusing on technological implementation or activity implementation), a political path (focusing on personal or professional interest, endeavor or enterprise), and a cultural path (focusing on how activities match with interests and endeavors of the users rather than the providers). These latter authors stressed that the most successful projects involved implementation practices that accounted for all of these paths, rather than one or two of these paths. A fundamentally important factor to consider in terms of implementation of mobile technologies, due to their mobility, access, and facilities, is the range of "actors" that are involved, how they are involved, and the individual contributory elements that need to be accommodated for each "actor" in terms of technical, political, and cultural paths. Technologies that were introduced and implemented in the past are now used to lesser or greater extents, but generally have not embraced the development of a systemic learning environment. If adoption of mobile learning technologies is to enable social learning and educational purpose, then it will involve a range of stakeholders and their acceptance of systemic development. The importance of selected activities using technology, the mediation or adaptation of use according to context, and the influences of and on the stakeholders clearly make the implementation of mobile technologies a case that involves "change" and involves "systemic change." Corbett and Rossman's implementation paths match the important elements that need to be considered in terms of an implementation framework for mobile learning technologies. But, as learning activities are clearly centrally important to successful and appropriate implementation, as learning that is socially constructed and conversationally constructed can be supported through mobile learning technologies, it can be argued that a fourth path needs to be specifically identified—a learning activity path. The four paths (learning activity, technical, political, and cultural), coupled with a concern for each stakeholder (pupils, teachers, school managers, local authority or project consultants, and parents), are selected here as a framework ("a systemic implementation framework for mobile technologies").

The next two sections in the paper show how schools have been involved in forms of "systemic change." The two case studies involved pupils and teachers in different geographical and local areas, with different technologies, and with a different focus on learning. The case studies will be used to describe and detail the four paths in the modified Corbett and Rossman systemic implementation framework. In particular, elements that show relationships between the paths will be highlighted. At the same time, this will demonstrate the important role of the learning activity path.

5 Implementing Mobile Technologies: A First Systemic Case Study

A first case study conducted by the author, briefly reported elsewhere [7], highlights practices that support "a systemic implementation framework for mobile technologies." The case study is reported using elements suggested by Yin [24]: an overview of the case study project (its objectives, issues, and topics being investigated), field procedures (including role of the researcher, access to sites, and sources of information including documents, interviews, and direct observation), case study questions (specific questions that the investigator explored during data collection), and an analysis of the results (in terms of relevance and relationship to the proposed framework).

The case study project was run as one initial element of a long-term regeneration program in a local community area. The initiative involved two primary schools in a locality with high socioeconomic deprivation, some 70 pupils in total (three classes of Year 6 pupils, 10 to 11 years of age), and provided them with individual personal digital assistants (PDAs). The PDAs were equipped with a wide range of utilities and software, selected to support educational uses across a range of subjects. The purpose of the initiative was to support attainment in core subjects, so there was a particular focus on uses of devices for literacy practices. Those pupils previously attending the schools in Year 5 (which included most of the 70 pupils) had gained prior experience of using PDAs. The teachers and teaching assistants involved with the Year 6 classes in the project (3 teachers and 3 teaching assistants) had no prior PDA experience, and encountered this technology for the first time. Initial training was provided for the teachers and

teaching assistants, with a project consultant providing ongoing weekly support for both schools. The PDAs had wireless and Internet access in school, but only a limited number of pupils had access to Internet facilities outside the school. Pupils initially used the devices in school only, but after a short time, teachers encouraged pupils to take them home, to support learning activities at home as well as at school. The project consultant identified relevant learning activities, and teachers used these activities within class lessons and to provide activities that pupils could continue at home, while school ICT co-coordinators provided additional in-school support (mostly operational). Most uses of PDAs focused on specific aspects of literacy (reading, spelling, and the use of vocabulary particularly). There was some limited use for writing (mainly associated with note taking), and for aspects of science, numeracy, video, image, and data capture. Typically, pupils read e-books, used an e-book dictionary as an instant learning tool, and traditional books were read alongside e-books for literature comparison purposes. Folders were created to collect, store, and allow specific groups of words to be reviewed, such as "wow" words and connectives, with a focus on punctuation, story openers, connective usage, and vocabulary. Pupils wrote a factual newspaper topic using annotation features of *MS PowerPoint*. *MS Pocket Excel* was used to look at averages, addition, multiplication, and formulas of differing kinds. Science records were taken of decay over time, captured as a photographic record. Images were captured, of mysterious, dilapidated buildings in the locality, as a stimulus to generate ideas for writing ghost stories. A local heritage site was visited, with PDAs used to capture images and take notes about costume drama activities led by the heritage site staff to show details about the Tudor period, written up into an e-book for pupils to share with others. Spellings were revised, with one pupil group collating spellings as both *MS Pocket Word* and sound files. An after-school club was run each school term, with some 15 pupils attending. Pairs of pupils developed short story writing, following discussion about author techniques with the project consultant. The recording tool was used to create sound files that acted as reminders for pupils of how to upgrade their written work.

The author was engaged by the regeneration project as an evaluator. The evaluation was undertaken independently; no direct intervention was involved, but some verbal feedback was given to the project consultant. A range of evidence was gathered from different stakeholders: structured individual interviews with open questions (four school ICT co-coordinators, 89 pupils, eight teachers, eight parents, four project consultants); four lesson observations; reviews of four items of pupil work; three sets of class results for writing and reading and two sets for spelling; two project consultant reports; and sets of national test (SATs) results for English, mathematics, and science for four successive years.

The evaluator explored aspects of the project concerned with management, implementation, learning activity development, learning outcomes, and responses of the various stakeholders. Questions posed by the evaluator (at two separate stages of the project) gathered feedback from stakeholders about training and ongoing support, ease of use of the devices and facilities provided, what learning activities the devices were used for (and in what subject topics), when pupils started to take PDAs home, whether teachers had evidence of enhanced learning in terms of reading, writing, spelling, and communication skills, the profile of literacy in the schools, reactions of pupils to the devices and learning activities, what perceptions and reactions of parents were, whether they felt they had become more interested or involved in their children's work, whether they felt their children's work had improved, whether they had used the PDAs, their involvement in supporting aspects of literacy, whether pupils felt the devices had helped with reading, writing, spelling, communication skills, doing "better" work, more work, and had led to increased engagement or interest in learning activities with their parents, and interests shown by employers, the media, or the wider community.

After two months of use, a first round of initial evaluation evidence was gathered. During those initial two months, pupil uses had mostly focused on the operation of the PDAs, but teachers had developed use for spelling practice (chosen for use when and as the pupil wanted, with or without help of peers or parents). Teachers, after two months of use of this facility, reported impacts on spelling. One teacher commented on the value gained when pupils were able to record spellings of words using their own voice, taking opportunities to revise them frequently. Listening to how to spell words, as well as reading the spellings, was felt to enhance memorization, retention, rehearsal, and recall. This initial implementation period was clearly crucial in terms of engaging the various stakeholders in the initiative. The learning activity path at that time focused on spelling. This form of focus met the needs of the regeneration program, as well as the needs of the school, and the likely interests (and involvement) of parents. From an implementation framework perspective, this learning activity involved and related to other key aspects. Training and support in the operation of the devices allowed this learning activity to be undertaken quickly (technical aspects). Spelling was recognized as a key basic learning need, highlighted nationally, recognized by school managers and teachers as being an aspect that needed to be practiced and developed, and recognized by parents as being a critical, basic skill set (political aspects). National interest in enhancing improved spelling was highlighted by the media; school managers and teachers wanted pupils to take an interest in improving their spelling, and they wanted parents to be involved and interested in supporting and encouraging this practice (cultural aspects). Critically important was the focus at that early stage, from the outset of the initiative, on a learning activity path that would involve and relate to the technical path (how to use the devices), the political path (engaging and involving all key stakeholders from the outset), and the cultural path (meeting the interests of as many stakeholders as possible). The initiative started by supporting political and cultural path involvement, rather than focusing just on the learning activity and technical paths.

After six months of use, a second round of evaluation evidence was gathered, and uses for learning had widened. Of 60 pupils interviewed, all except one were engaging

positively with use of the PDAs, and 54 of the pupils were able to recognize and state specific features of PDAs that they said helped with spelling. Spelling results retained in both schools suggested that pupils were improving in terms of their spelling (although it was not possible to make a comparison of these results with those of other independent groups to check whether this improvement might have been expected without the use of PDAs). Importantly, enhanced social levels of interaction for learners were reported—parents had become more involved in their children's schoolwork once the pupils had taken the PDAs home. Of the 60 pupils interviewed, 57 said that parents or family were more involved. Of these pupils, 42 gave details of how their parents or family were more involved. The ways most commonly reported were helping them to revise for tests, with times tables, with reading, or with schoolwork generally (in 17 cases), and regular checking of work (in 16 cases). Interviews with eight parents indicated that they were generally positive about the focus and nature of the initiative. One parent reported that the medium had helped his child (with autistic tendencies), to express emotions and feelings more, as the child was able to write in response or when relevant, rather than having to say things in response, which was much more challenging for the child. Many parents and family members of the 60 pupils involved had used the PDAs, often supporting activities involving literacy. But the PDAs remained personal tools rather than tools shared across the family. At this stage, in terms of implementation paths, it was clear that while learning activities had widened, they were still created in ways that would allow the other three paths to develop at the same time. While the learning activity path involved reading, writing, numeracy, and data capture to greater extents, the other paths were accommodated at the same time. The technical path developed—gaining more experience and training in using different device features, and sharing these with parents. The political path developed—maintaining a focus on learning recognized as being nationally important, important for teachers and school managers, and for parents. The cultural path developed—allowing learning activities to be brought to the awareness of parents, and involving parents in ways that allowed topics to be introduced and practiced in conversation, and through discussion.

Pupils, teachers, and parents recognized that impacts on learning were more effective when PDAs were used alongside or with other resources (human interactions). This conclusion is supported by findings from a separate study reported by the author [7], which explored impacts of a project that developed a range of multimedia resources for access on PDAs. In this case, learning using mobile technologies was evidenced in informal as well as formal learning settings. Some pupils were involved in learning activities that supported the learning of others. For example, some pupils produced images with text and audio, and made these accessible to a Chinese girl (a non-English speaker), to help her learn English. This example involved potentially high-level aspects of learning (analysis, synthesis, evaluation), as well as emphasizing the role and impacts of "caring as thinking" (Lipman [25]). Across that project, some mothers reported having a greater awareness of what was happening in terms of learning and other activities in the school, and being able to monitor what was happening to their children in terms of learning on a day-to-day basis. They reported enhanced confidence, that their children were more creative and more enthusiastic, and that their literacy had moved on more. Sharing, both with peers and with parents, was recognized as an outcome and as having impact, with pupils talking more about their learning (how, as well as what). It was reported that applications were in some cases encouraging discussion about learning, and that this was happening to a greater extent than had happened when the focus of discussion was through subject or topic content. Pupils felt that they could learn at any time, and that the features enhanced their persistence (what one local authority consultant called "stickability"). The project was reported to have opened up new dimensions for some teachers. A teacher of hockey encouraged pupils (9 to 10 years of age) to capture video, images, and audio during a hockey match, to interview players to find out what they felt, and to keep a record of results. This allowed all the pupils in the class to be engaged—including those not able to play. Software features of the PDAs allowed aspects of a science lesson to be captured on video (by 11 to 12 year old pupils) and for details of the experiment and the results to be "written up" as they happened in *MS Word* or *MS Excel*. Using other software features, pupils were able to access material to revise, or to create revision tools (a flip chart of the animation of a life cycle of pollination, for example). Again, forms of learning activities were central to implementation, and while the learning activity path involved activities that included important social and societal aspects, they also involved the three other paths. The technical path was involved as learners needed to develop uses of specific software and features to undertake successive learning activities, but also doing this through sharing and discussion. The political path was involved, as different stakeholders were involved, in aspects that they felt were important. The cultural path was involved, as parents and others were involved actively in encouragement for and contributing to the learning needs and outcomes of their children.

That implementation adequately considers each of the four paths is reinforced by evidence from other research into uses of mobile learning technologies. The importance of the cultural path was indicated in a study [4] that looked at learning involvement where mobile device use matched experiences and practices that young people were already engaged in. This study of pilots involving nearly 250 "hard to reach" learners (aged 16 to 24 years) in the UK, Italy, and Sweden reported that "smartphones" could provide ways to motivate numbers of young adults who were not in employment, education, or training, with about four out of five young people reporting that they felt mobile games could help them to improve reading, spelling, or mathematics. However, it should not be assumed that access to mobile technologies would in itself lead to learning engagement, without implementation and provision of adequate support and preparation. A recent study for Becta (Passey et al. [26]) indicated the importance of the technical path. Although evidence in this research suggested that young people have wide access to mobile (and less mobile)

technologies, the technologies used mainly for learning were computers with Internet access and televisions, both much more fixed than mobile. Mobility features were reported by these young people to be used for social purposes, while links to learning through mobile technologies were not strongly made by many of these young people. Teachers and schools have vital roles to play; they can provide access to and involvement with mobile technologies to support learning. But learners are only likely to be able to gain from this effectively and in the longer term if mobile learning technologies are implemented with an adequate focus on all the four implementation paths.

6 Implementing Mobile Technologies: A Second Systemic Case Study

The second case study looks in more detail at implementation integrating all four implementation paths, and indicates how a school in a geographical location separate from the first case study school employed strategies to do this. The case study is reported using the same elements as those in the first case study (Yin [24]).

This second case study describes the introduction and implementation of sets of handheld mobile devices in a primary school located in a suburban area. The school provides for a wide catchment population, with some 48 percent of pupils coming from outside the immediate locality, many from local council wards with high levels of social deprivation. With pupils from widely mixed backgrounds, the school is concerned that it provides a learning environment for pupils who have different starting points, with regard to prior learning, social confidence and literacy, and levels of background opportunity. The school is concerned that pupils' social aspects, as well as their learning, can be developed positively. The head teacher ran a mobile learning project in a previous school. From that experience, he felt that mobile learning devices could support the learning and wider social needs of a specific year group within the school. This group had a higher number of pupils with special educational needs (14 out of 66), compared to the attainment performance of prior Year 5 groups. The school secured a number of handheld mobile devices some two months before the end of a school year so that pupils and teachers could explore aspects of use before the start of a new school year. Three teachers and 66 pupils aged 9 to 10 years in three Year 5 classes were each provided with a mobile device that could access the Internet via the school wireless network. The mobile devices were provided for this year group with the intention of supporting more positive engagement with learning, and of supporting their learning to improve performance in the longer term.

The classes were streamed for numeracy and literacy lessons, but otherwise they worked in registration groups (in mixed groups). For streamed numeracy and literacy sessions, there were three streams—a highest attaining stream and two other equal groups. Teaching assistants were deployed across the three classes, and worked in different classes and groups according to the particular needs of those groups. The Year 5 rooms where the three classes were taught were arranged loosely in an open-plan pattern, each having an interactive whiteboard, with three computers and a monitor located centrally. The teachers, taking advice from the head teacher and a local authority (LA) consultant, devised activities and managed uses of the devices both to engage the pupils and provide learning activities that would support specific learning intentions. In general, pupils used the mobile learning devices in school every day, in activities appropriate and relevant to the curriculum prepared by the teachers (who worked jointly on lesson planning). Pupils typically used mathematical games to practice certain techniques, to take notes during lessons to develop into reports or stories later, and to take images of plants and animals in outside locations and using a biological key to identify them. They took images of leaves over a time period and created a presentation to show changes over time, used a spell checking resource to practice the spelling of specific words, and took images or video of physical education activities, keeping scores, and taking notes to create sports reports later. They accessed homework assignments on the learning platform, completing and uploading them onto the platform. They accessed and researched details about specific topics including local heritage sites using the Internet, wrote in a range of genres, including writing from different points of view, and created audio files of a partner's story. The LA consultant attended regularly one day a week from the outset of the initiative and taught classes different ways to use the devices. He took on the role of technical troubleshooting where possible, supporting access to and content on a learning platform provided by the LA. Pupils used the devices in lessons, and at breaks and lunch times, in the playground and in outside areas. Pupils took the devices home; parents owned the mobile devices (they paid a monthly fee). Mobile devices were charged at home, at least once a week, and it was recommended that this be done on Sundays. Technical support came from the LA; technical jobs were accumulated and these were addressed within half a day each week. If problems arose unexpectedly, the school ICT coordinator addressed issues where possible on a day-to-day basis.

The school was selected for case study exploration initially because it was recognized by a national technology solution provider as being a lead school in terms of implementation of mobile devices integrated with other forms of technological support. The school agreed to involvement for case study purposes, and the author undertook an independent case study evaluation. The evaluation was not intended to provide any direct intervention, although feedback was given to the school so that it might consider ongoing and longer term approaches. Evidence was gathered during two visits to the school, and comprised: individual semistructured interviews with open questions (two head teachers, 36 pupils in groups of four to six, six teachers, one parent, two LA consultants); three lesson observations; and a review of the LA consultant's learning log. The learning log, maintained by the LA consultant for his own purposes, described learning interactions arising each week, and this was made accessible to the author.

The evaluator explored aspects of the project concerned with management, implementation, learning activity development, learning outcomes, and responses of the

various stakeholders. Questions posed by the evaluator provided feedback from the stakeholders about training and ongoing support, ease of use of the devices and facilities provided, what learning activities the devices were used for (and in what subject topics), when pupils started to take the mobile devices home, whether teachers felt or had evidence of enhanced engagement with learning and enhanced outcomes of learning in terms of researching, reading, writing, spelling, communication skills, and independent learning, when and how often pupils used the devices, the reactions of pupils to the devices and learning activities, whether pupils felt they had become more interested or involved in their work, whether parents felt their children's work had improved, and whether pupils felt the devices had helped them with learning skills, reading, writing, spelling, communication skills, doing "better" work, more work, and whether use of the devices at home had led to increased engagement or interest in learning activities with their parents.

It is of note that both in this project, and in the project described in the first case study, the implementation of mobile learning devices happened quickly, within a matter of months. Phased implementation frameworks, therefore, may well have limited value in terms of introduction of these forms of device. This rapid introduction in preparing for a wider implementation appears to be due to at least four factors. First, the devices are portable, degrees of ownership are high, use is made of the devices very often, and high levels of practice lead to high levels of operational facility very quickly. Second, forms of systemic implementation of the types described enable users to gain from the wider experience and involvement of all those included, with pupils sharing their experiences and knowledge with teachers and parents, and vice versa, leading to levels of use based on shared systemic knowledge. Third, the focus on learning activities that then develop operational abilities supports engagement of all stakeholders. Fourth, involvement of an LA consultant, coupled with support from a head teacher and commitment from teachers, provides forms of reflection and feedback that drive forward development positively.

In terms of the systemic implementation framework, features were identified through the case study that showed the roles of and interactions between each of the four paths. At an early stage of the pilot, it was clear from feedback that implementation had been successfully managed at a number of levels. There was no malicious use or damage reported, devices were reported to be working without major problem, and pupils were reported to be very highly motivated (with other year groups indicating their desire to be involved also). It was found that Internet access was essential—even at the outset of the pilot it was clear that problems arose if this access was not available. The success of the initial introduction of mobile technologies clearly relied in part upon the school's management and planning of pupil and parent expectations—pupils were shown in advance when to turn off the volume on their machines, and the need to charge batteries, for example. The mobile devices were used in school routinely, every day, but selectively, according to appropriateness and relevance. Initially, teachers judged this appropriateness and relevance, but after only a few months, pupils themselves were given the responsibility to make and take such judgments. The learning activities selected and devised by the teachers were clearly vitally important; they engaged the children in school, but were also linked to the needs identified by the school management, and to the interests of parents (supporting the political path). The fact that parents owned the mobile devices and paid a monthly sum and that they were charged at home also supported the political path (parental commitment and interest was maintained and managed). But it also supported the cultural path, as parents were involved in maintaining elements of a systemic learning environment, including the home and outside areas such as a car or a garden, and the school and its outside areas. Additionally, the technical path was supported, as parents were involved in maintaining charged units and liaising if technical faults arose (also involving the LA, who provided regular technical support).

Discussions with groups of pupils (12 pupils in total), four months after they received the mobile devices, indicated a range of outcomes that highlighted how learning activities were supporting aspects of the technical, political, and cultural paths (as well as focusing on important learning aspects associated with social and societal interactions). Pupils reported that they used the mobile devices in lessons routinely, on occasions each day, and also a great deal at home. They reported that mobile devices were enhancing learning opportunities and ways that learning could be developed. In an example described by all pupils interviewed, pictures were taken of wildlife, of plants and animals in different locations. These pictures were used with a resource called *Wild Key* (a range of biological keys to help identify animals, plants, leaves, and trees, linked to habitats), as they could be viewed when answering questions in the key. Some pupils afterward used *Wild Key* at home to look at and identify minibeasts. This practice supported an important transfer of learning, use of techniques in different locations and in different contexts. It also involved both a societal and social dimension, as parents could see what sorts of practice their children were involved in, and had the potential to discuss this with their children, which, in turn, supported aspects of the cultural implementation path. Many pupils felt that homework could be done more easily, and one pupil reported completing homework in the family car; again, the cultural path was supported by this practice. The devices also provided choice; different pupils did writing in different ways, using a keyboard or a stylus. This offered choice for the pupil, and supported both political and technical paths in terms of selection and use. These paths were also supported as pupils could write using the mobile devices. This method was preferred in some cases as spelling could be checked more easily, the writing process felt more comfortable, and the device allowed writing to be done more quickly (potentially matching cognitive speed to motor speed for some pupils). The fact that pupils were engaging in writing, and parents could see this, also supported the political path for the parent, since parents already recognized the importance and value of writing and

spelling. Examples also indicated how selected learning activities could support cultural and political paths for both parents and pupils. Mathematical games were accessed by one boy when on holiday to find out how to carry out certain tasks in mathematics. For his parents, the political path was supported, as mathematical abilities are recognized as being important, and the cultural path was supported, as the parent is providing the opportunity for that activity and practice to take place. For the pupil, the political path is supported, as interest in mathematics can be fulfilled, and the cultural path is supported, as the parent is providing the opportunity, and the teacher and school are providing and pointing to the available resource. Some pupils reported undertaking learning activities that allowed them to pursue more independent learning. One boy took images of leaves each day and created a slide show to show changes over time. Literacy, writing, and correcting spelling were a focus for one girl, while for a number of pupils, information from the Internet could be accessed easily and used at home and in school. Other pupils reported undertaking learning activities that clearly supported the cultural path, involving levels of social interactions. Images or video of physical education activities were recorded, scores were kept, and notes were made and reported later. Some pupil work was shown, discussed, and shared through the classroom interactive whiteboard. Homework or pictures could be completed or taken and then accessed easily in school. The voice recorder was used to record a partner's story about what they did on holiday.

As the project progressed, connectivity issues highlighted the importance of the technical path, and it was clear how this affected the cultural path (limiting access to opportunity as needed) and the learning activities path (limiting access to subject and topic details, and learning exploration routes as needed). Technical, cultural, and political paths for pupils and parents were supported strongly by pupil involvement in an online course. Teachers offered a mobile technology course provided by Roehampton University [27], introduced so that some pupils were completing it six months into the school year. Within weeks of starting it, 35 pupils had completed the course and had passed Level 1, while all pupils completed it and were presented with certificates at a special celebration event within a few months. Teachers and the LA consultant recognized that a range of pupils had become highly proficient in terms of using the mobile devices as they were completing the course. The technical expertise of some pupils had developed to the point where it was possible to consider deploying "experts" in teams, to develop the sharing of practice. It was felt that such deployment could support wider and longer term development of independent learning, encouraging discussion with peers, at home, in school, and during break times. It was clear that the technical path had been supported (pupils were gaining operational abilities), the political path had been supported (parents recognized the value of the course certificate), and the cultural path had been supported (pupils were sharing their abilities across a learning network of peers, teachers, and parents).

The learning network that was developing was supported positively by access to a learning platform. Pupils were able to access a range of facilities from the LA learning platform through their mobile devices at the same time as they were taking their online course. They were able to log on and access specific Year 5 pages and resources. They could access homework provided by teachers and could upload their homework. They were able to access e-books, Website links (such as links to sites about space), Websites offering resources created by local historical and heritage sites (images and audio), and software programs (in case these programs were lost from their mobile devices). The learning platform played an important role in providing sharing opportunities across schools; 15 primary schools in the LA used the learning platform with pupils and had done so for 2 years prior to that date. The LA consultant set up discussions that all of these schools could contribute to, and pupils at the case study school contributed to some of these discussions. Access and use of the platform clearly supported the technical path, sharing opportunities supported the cultural path, and the reported value of making contact with others outside the school supported the political path.

Homework played an important part in the support of implementation paths. Homework was completed using handheld mobile devices. Pupils were set one homework activity each week, these were completed at home, and the files were uploaded to a specifically named folder (and pupils were able to see everyone else's homework too). During one specific week, for example, the homework set was written from a "different point of view." The teacher was able to access some pupils' work from the folder access area on the learning platform and discuss these using the interactive whiteboard facility with all pupils in the class. Homework being managed and completed in this way was reported to have positive effects on parents. Parents reported to teachers that their children told them more about their homework and work generally. Parent reports indicated recognition of the technical path (parents could see the technical abilities of pupils needed to undertake these activities), the political path (the value of the device and the system in which it operated was being recognized), and the cultural path (the parent was becoming more involved in the system, and more aware of what was happening).

Important outcomes relating to individual children were recognized and reported by some parents. A parent reported to the head teacher that a child used the device to look at what he had done previously and to look at what he needed to do at the beginning of each day. He did this in the morning (at a time and place to suit him); it was clear that he could not easily have done this in the same way without the mobile device. The device offered him ease of access, and enabled him to review his learning, using the device both as a reflective medium but also as a preparative medium. Both the pupil and parent were seeing benefits and becoming more involved in the overall learning network. Another parent of a boy in one class, who provided some direct feedback about her experiences, indicated that she thought that the mobile device had brought about noticeable changes in her son. At an operational level, the large positive difference that was noticeable was confidence in use of the mobile device, working on it independently, being able to

use facilities such as *Bluetooth* and downloads for music (relating to the technical path). Although the monthly payment was felt to be quite high, it was recognized at the same time that the device was used a lot, in almost every lesson, and the level of use inside and outside school was felt to warrant the cost involved (relating to the political path). A difference that she noticed was her son's abilities with literacy when the mobile device was used. Although the boy "struggled with literacy" generally, this was not the case when the mobile device was used, as he could seek and gain help from other pupils (relating to both the political and cultural paths). There was an associated recognized rise in his interest in aspects of learning, and his view of barriers to reading that had existed previously did not manifest themselves in the same way. Overall, a "dramatic change" was reported in terms of engagement with and increased independence in learning. It meant that he then had something positive that he wanted to do at home on dark nights when there was bad weather. The parent was impressed with what he had done, and she felt he had "grown up," taking more ownership and responsibility for items such as the mobile device (relating to both the political and cultural paths). The parent felt that the approaches taken by teachers were encouraging greater responsibility levels, inculcating individual responsibility at the same time as encouraging sharing, so that children were not embarrassed to ask others for help (which the parent felt would not be expected in other circumstances). With Year 5 being the only group with mobile devices, the parent felt that this enhanced self-esteem of this group, it encouraged them to talk readily to each other, and might well be leading to greater social cohesion and participation. The parent was indicating successful outcomes relating to the intentions and aims of the project set out by the head teacher. At the same time, the parent was indicating the importance of the four paths—the forms of learning activity involved, the operational abilities and access to facilities provided, the value of the outcomes and how they were applied to the child's individual circumstances, and the opportunities that were afforded in terms of social contact and cohesion.

When pupils were half way through their Year 5 school year, they reported on uses of mobile devices within classrooms, in the school outside classrooms, and at home, which indicated that learning activity, technical, political, and cultural paths had been managed and implemented successfully, both for them, and by them. Relating to the learning activity path, they reported that they used the handheld mobile devices a lot to complete homework activities, involving writing, drawing, saving and carrying on working whenever it was possible (in a car, for example), storing and inserting pictures, spell checking without a teacher being there, downloading e-books, searching on the Internet, taking pictures on holiday and writing about them, using resources such as *Textwise*, *Paint*, *Smart Notebook*, *MS PowerPoint*, *Pocket Slides*, putting files together with ease, using different sources rather than being constrained by details only available in books, taking notes and photos in lessons or outside school, helping them to write stories or a newspaper report, and accessing games (such as *Textwise*, *Sums Online*, *Bubblebreaker*, to help with learning). Relating to the technical path, they reported that the handheld devices were easy to use, as use did not involve having to carry papers, that it was easy to carry them around, as they could be put around their neck or on a belt, that they could use an overview keyboard for writing something short, or a larger keyboard for longer writing, that the learning platform facilities were easy to access, and files could easily be handled, uploaded, or downloaded. Relating to the political path, they reported that the handheld mobile devices encouraged parents to ask about and take interest in their work, they could show their parents how to use *Pocket Slides*, show photos of class activities to parents, and use a transcriber to check handwriting. They said that these activities led to parents being more interested in their work than if they had done it by hand or in a book, as parents could see more easily what they had been doing at school. Relating to the cultural path, they reported that the handheld mobile devices allowed them to enjoy work more, that they were used at break times, to exchange files, games, or images, to send things to each other, such as exchanging music files, and through *SynchonEyes*, allowing teachers to see what was happening.

Teachers reported success against initial intentions at that time. They reported that some pupils were engaging more in foundation subjects and literacy. They reported that the mobile devices allowed research to happen prior to subjects being undertaken in class, and that this preparation had an impact on engagement. Teachers reported that pupils were offered more choices through technological features and that the skills of some pupils meant that children were communicating and asking more as a consequence. While teachers were enhancing independent learning and the responsibility for learning, pupils were increasing in terms of their self-confidence and self-esteem, responsibility, and communication.

The positive indicators of success across the pilot were clearly associated with the four paths of implementation, integrated through activities and actions for and with the stakeholders involved: a positive lead and ongoing support provided by the head teacher; the direction and forms of activities that were introduced by the three class teachers; the ongoing support and ideas offered by the LA consultant; the continued willingness of parents to invest in the devices and to be increasingly interested in their children's learning; and the engagement of pupils with the facilities and their willingness to share and contribute ideas and outcomes. Pupils, teachers, and parents all reported positive impacts arising. In particular, they reported on successes concerned with: the learning activity path (increased engagement with learning, including literacy and other foundation subjects, and more efficient ways to manage their learning); the technical path (ease of use of the mobile devices and facilities); the political path (increased interest and engagement about learning with parents); and the cultural path (increases in the range of places and times when learning was recognized and happening, provision of additional learning opportunities and ways that learning was developed, a more positive linking of learning outside and within the school, and increased levels of social interaction and forms of communication).

It was clear that there had been important outcomes for pupils as a whole, but that different pupils had gained in different ways. For example, one child used the device to

look at what he had done previously and to look at what he needed to do during any one day. The device offered him ease of access to review his learning. The implementation was sensitive to individual needs and concerns, supporting paths concerned with learning activity (at an individual level), political (of value to the individual), and cultural (allowing individual interests to be supported but providing for involvement within a wider learning network system). While specific impacts were reported, wide impacts at a social networking level were recognizable in some cases also. One teacher reported on the year group that she had taught for the past three years, on a change in their attitude to learning during this project year—particularly of the weakest pupils. She found that they were more positive and engaged more readily. Another teacher reported that pupils with special educational needs felt more a part of the activities—they could write and do literacy more easily. Teachers felt that pupils after some six months of use regarded the mobile device as a tool like many others—it was something they could choose to use when and as appropriate. Observations in lessons indicated that pupils used the mobile devices in balance with other media (including paper), that they used them to support independent learning, and within an environment where approaches offered levels of flexibility to individual access and use.

Evidence from this case study indicates the need for positive development of high levels of cultural acceptance and commitment across the systemic arena (the formal and informal, home and school learning context). It also indicates that the systemic approach adopted recognizes that individuals have important roles to play, but that the ways in which these individual components build into a wider systemic approach also need to be accommodated.

7 A Systemic Implementation Model for Mobile Technologies

The importance of understanding the relationship among learner, teacher, and parent or caregiver, if mobile technologies are to be implemented successfully, is highlighted by Winters [28] in the Kaleidoscope Report, for example. In the case study examples in this paper, mobile technologies have been used routinely, outcomes for learners have been enhanced through home supported use, and their appropriate application has been supported by committed teachers and encouraged through project or LA consultants. Using a modification of the Corbett and Rossman [23] implementation paths model, different factors influencing implementation can be identified and examined for each stakeholder or "actor." It is clear from evidence about implementation involving this range of stakeholders or "actors" that political and cultural factors are involved in successful implementation just as much as technical or learning activity factors.

The adoption of mobile technologies for learning is substantially different from the adoption of other school-based technologies. Mobile technologies travel; they go home and outside school, so the technology interacts directly with a number of "actors" as do the resources and materials on the technologies at times and places chosen by the learner. Although many homes have computers and Internet access, fewer have mobile technologies (laptops, PDAs, or other devices such as smartphones). As mobile devices move with the learners, ownership tends to be much more firmly established with the individual. Although uses of mobile technologies may be shared with others at home, their movement with the user means that ownership resides with the learner, rather than with the teacher, the school, the parent, or the family. The focus of use, therefore, needs to be with the individual learner. Implementation practices need, therefore, to look at the roles of the other stakeholders, but to place the learner in a central implementation position rather than the school or teacher as implementer. The roles that teachers take in supporting mobile technologies in classrooms are not the same as the roles taken in supporting nonmobile technologies, and indeed, it has been recognized that some schools and teachers restrict uses of mobile technologies and that it could be argued that this has been done in order to ensure that the roles remain as they have been. The roles of the schools, and the roles of the parents and family members or friends are not the same. Although the relationship between individual stakeholders and between paths within the wider systemic approach is clearly important, it is also important that individual stakeholders can recognize how they need to contribute to the paths to enable a wider implementation picture to be successful. The roles and activities of individual stakeholders (pupils, teachers, school managers, project consultants, and parents) in terms of each implementation path will be summarized in this section.

Implementation of the learning activity path is central to success. It can make the difference between involvement of pupils in learning activities that replace those activities already running within classrooms and pupil involvement in activities that benefit them not only from a focus on learning aspects that are difficult to support through other media, but also benefit from potentially wider involvement with peers, parents, and carers. At this stage of national and international mobile learning development, useful and effective examples of learning activity practice are recognized. Making these activities accessible could support those who might include them in their planning and implementation patterns. There is need for a range of different learning activities to support learners, teachers, and parents at different stages of implementation, starting with those that account for the skills and capabilities of all the stakeholders at early stages, moving through to later activities that rely upon wider and deeper operational and learning skills. Factors contributing to success within this path are the following:

- For the head teacher—recognizing the learning potential of the devices; providing opportunities for discussion, reflection, and monitoring.
- For teachers—identifying and selecting appropriate learning activities; supporting activities focusing on important aspects of learning; allowing and mediating the development of activities focusing on social, metacognitive, and megacognitive aspects of learning; involving parents on a regular basis with learning activities; gaining feedback about impacts and successes of learning activities; providing pupils with opportunities to exercise increasing independence as to when and where to use devices inside

and outside the classrooms; widening learning activity uses each school term.
- For parents—being willing to be involved in supporting learning activities with children; monitoring how devices are being used and whether impacts can be recognized; supporting appropriate social as well as educational uses of devices.
- For a project or LA consultant—providing effective learning activity exemplars.
- For pupils—being willing to explore learning activities using devices; being willing to explore uses of devices inside and outside the school.

Evidence from the case studies indicates that the technical path is important for successful implementation. Indeed, while some schools have levels of internal support for desktop computer systems, network and server infrastructure systems, and for internal wireless systems, fewer report having internal support with specific experience or expertise in the area of mobile systems. Some LAs find the provision of this support to be a challenging area. Factors contributing to success within this path are the following:

- For the head teacher—gaining advice on usability and usefulness of specific devices; enabling technical support; ensuring a range of resources on devices, including Internet access, to allow important learning activities to be undertaken.
- For teachers—offering plans to manage the operation of devices and how pupils and parents will maintain these; providing opportunities for pupils to develop technical and operational skills at the same time when undertaking selected learning activities; providing opportunities for pupils to share their technical knowledge with others.
- For parents—gaining awareness of how to maintain and manage the operation of the devices; being aware of technical routes to follow if required.
- For a project or LA consultant—providing technical support or advice regularly; maintaining Internet access inside and (where possible) outside the school; providing facilities that allow pupils and teachers to keep and share resources; providing opportunities for pupils and teachers to engage with others in other schools.
- For pupils—gaining technical and operational skills while undertaking learning activities; seeking qualifications to demonstrate technical and operational skills; sharing skills willingly with others.

Evidence from case studies indicates that accommodation of the political path can determine implementation patterns as well as levels of success. When planning an implementation, head teachers or LA consultants find that they need to recognize and match interests and aspirations of parents as well as pupils. They can find that there is "timeliness" to implementation action; some parents may be resistant to ideas of mobile learning at certain times, while at others, they are less resistant. The role of evidence to support implementation is found by some head teachers to be important to some parent groups, while other parent groups wish to take on board concepts of leading innovatory initiatives (Rogers' model [17] appears to apply here to parent groups as much as to teachers). Factors contributing to success within this path are the following:

- For the head teacher—being willing to take a positive lead; involving parents in "buy-in"; accommodating the likelihood of shifting concerns by different parties; building in the legitimacy of undertaking activities with mobile devices for all parties; accounting for an impact dip if this arises.
- For teachers—being willing to tell pupils that they can use mobile devices as they wish even in lessons; introducing mechanisms to allow pupils to support each other; capturing important uses and outcomes to share them with others.
- For parents—being willing to accept that mobile devices are legitimate resources to support a range of important learning activities.
- For a project or LA consultant—being aware of and offering ways to support a system involving teachers, parents, and pupils.
- For pupils—being willing to explore different features offered by the devices knowing that this is legitimate.

Accommodating the cultural path is vitally important in the implementation of mobile learning initiatives. This path can determine not only the levels of involvement of stakeholders but also the quality of learning experiences. It is recognized that parents can influence learning, either positively or negatively (see, for example, the findings and discussion offered by Henderson and Mapp [29] and Wolfendale [30]). Mobile learning provides opportunities to involve parents positively; mobility and access mean that parents can be involved when and where opportunity and questions arise. Supporting and involving this dimension, working toward practices that account for these elements, could well help to shape more easily a learning system that enables young people to interact across and between a range of informal and formal elements (at home, in a museum, in the garden, in the classroom, in the playground, in the car, on the beach), and to make and take decisions about learning appropriateness at the times when opportunities arise or emerge. Factors contributing to success within this path are the following:

- For the head teacher—providing ways for all parties to gain ownership of learning involvement; involving parents and pupils in learning endeavor; managing parental expectations; enabling regular discussions with parents, teachers, and pupils.
- For teachers—managing pupil expectations; providing regular learning opportunities that are home- and out-of-school-based; celebrating successes and allowing pupils to gain qualifications; providing for the sharing of ideas and how individual pupils have used the devices.
- For parents—being willing to purchase or part-purchase devices; accepting involvement in educational and learning practices; allowing children to use devices as they see fit.
- For a project or LA consultant—supporting sharing across the stakeholder groups, of technical, operational, and pedagogical features.

- For pupils—developing capabilities enhancing independence of action and engagement with learning; exercising judgment about choice of approaches and media to suit learning needs.

In some cases observed, early implementation has focused on selected learning activities, often involving a limited range of the full resources, such as a spelling test facility. However, it is clear that a diversification of learning activities is feasible within a year from the outset. Research focusing on the progressive nature of implementation practices might be a worthwhile endeavor for the future. Certainly, continued research would provide opportunity to identify important features of a developing home-school dimension, to consider more the importance of certain political and cultural factors as implementations and time progress, and to offer recommendations for longer term and wider parental involvement.

The framework proposed does not attempt to provide a "blueprint" for schools. As cautioned by Hartnell-Young [31], there is a need for schools to consider their individualistic needs according to a range of cultural and political factors. The framework proposed does, however, provide overall guidelines that schools should consider for implementation. Schools successfully managing implementing mobile technologies and gaining positive learning outcomes have placed the learning activity path central to the implementation endeavor, but it is clear that elements of the other three paths can determine aspects of quality and depth of the learning experiences and impacts arising. School development plans can play a key role in respect to specific contexts (see MacGilchrist and Mortimer [32]), since school development plans provide an opportunity for schools to consider and take into account individualistic cultural and political circumstances. For example, schools are likely to want to handle "buy in" in specific ways; some might want to encourage entire financial commitment from parents, while others might want to support part-payment. Similarly, some schools might want to involve specific classes in a first year implementation, while other schools might want to involve whole year groups. Some schools might want to run awareness-raising sessions for parents in the evenings, while other schools might want to ask parents to join their children in classes during the main school day.

8 Conclusion

The framework offered in this paper proposes that implementation of mobile technologies considers four parallel paths (learning activity, technical, political, and cultural), all being important at all stages of implementation, with a central focus on learning activity. This framework proposes the importance of involving and accommodating cultural and political factors from the outset of implementation, rather than at later stages of implementation. Indeed, the evidence indicates that because of differences between the nature of mobile technologies and the nature of desktop computers, a failure to accommodate political and cultural factors from the outset is likely to substantially limit involvement of important learning activities. If these aspects are not considered from the outset, certain measurable and identifiable impacts (concerned with parental awareness and involvement, and with individual pupil support, for example) are likely to be substantially reduced (or eliminated). Mobile technologies have the potential to impact in some key areas of learning, but teachers alone will be unlikely to bring about the width of implementation needed. Implementation of mobile technologies is a case where systemic change and implementation need to be recognized, key "actors" need to be involved, and implementation factors important to each stakeholder group need to be accommodated.

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References

[1] J. Roschelle, "Unlocking the Learning Value of Wireless Mobile Devices," *J. Computer Assisted Learning,* vol. 19, no. 3, pp. 260-272, 2003.
[2] D. Perry, "Hand-Held Computers (PDAs) in School," Becta, 2003.
[3] L. Naismith, P. Lonsdale, G. Vavoula, and M. Sharples, "Report 11: Literature Review in Mobile Technologies and Learning," Futurelab, 2004.
[4] J. Attewell, "Mobile Technologies and Learning: A Technology Update and m-Learning Project Summary," LSDA, 2005.
[5] A. McFarlane, N. Roche, and P. Triggs, "Mobile Learning: Research Findings—Report to Becta," Becta, 2007.
[6] C.-H. Lai, J.-C. Yang, F.-C. Chen, C.-W. Ho, and T.W. Chan, "Affordances of Mobile Technologies for Experiential Learning: The Interplay of Technology and Pedagogical Practices," *J. Computer Assisted Learning,* vol. 23, no. 4, pp. 326-337, 2007.
[7] D. Passey, "The Role of Mobile Technologies in Moving 'Digital Natives' to 'Learning Natives'," *Proc. World Conf. Mobile and Contextual Learning 'The Bridge from Text to Context' (mLearn '08),* J. Traxler, B. Riordan, and C. Dennett, eds., pp. 224-231, 2008.
[8] B.Z. Presseisen, "Thinking Skills: Meanings and Models Revisited," *Developing Minds: A Resource Book for Teaching Thinking,* A.L. Costa, ed., third ed., pp. 47-53, ASCD Publications, 2001.
[9] D. Moseley, V. Baumfield, J. Elliott, S. Higgins, J. Miller, and D.P. Newton, *Frameworks for Thinking: A Handbook for Teachers and Learning.* Cambridge Univ. Press, 2005.
[10] G. Pask, *Conversation, Cognition, and Learning.* Elsevier, 1975.
[11] L.S. Vygotsky, *Mind in Society: The Development of the Higher Psychological Processes.* The Harvard Univ. Press, 1978.
[12] *How People Learn: Brain, Mind, Experience, and School,* J.D. Bransford, A.L. Brown, and R.R. Cocking, eds. Nat'l Academy Press, 2000.
[13] "Anytime from Steljes: Beatrix Potter School," Steljes, 2008.
[14] S.M. Hord, W. Rutherford, L. Huling-Austin, and G.E. Hall, *Taking Charge of Change,* Assoc. Supervision and Curriculum Development, 1987.
[15] CBAM Summary, *Rural Successful Schools,* Northwest Regional Educational Laboratory, 1990.
[16] J. Waycott, "The Appropriation of PDAs as Learning and Workplace Tools: An Activity Theory Perspective," PhD dissertation, Inst. of Educational Technology, The Open Univ., Milton Keynes, 2004.
[17] E.M. Rogers, *Diffusion of Innovations,* fourth ed. Free Press, 1995.
[18] F.D. Davis, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly,* vol. 13, pp. 319-340, Sept. 1989.
[19] Y. Engestrom, "Developmental Studies of Work as a Testbench of Activity Theory: The Case of Primary Care Medical Practice," *Understanding Practice: Perspectives on Activity and Context,* S. Chaiklin and J. Lave, eds., pp. 64-103, Cambridge Univ. Press, 1993.

[20] S. Hooper and L.P. Rieber, "Teaching with Technology," *Teaching: Theory into Practice,* A.C. Ornstein, ed., pp. 154-170, Allyn and Bacon, 1995.
[21] M. Fullan, *Leading in a Culture of Change.* Jossey-Bass, 2001.
[22] Z.R. Mevarech, "The U-Curve Process That Trainee Teachers Experience in Integrating Computers into the Curriculum," *Proc. IFIP TC3 WG3.1/3.5 Joint Working Conf. Information Technology: Supporting Change through Teacher Education,* D. Passey and B. Samways, eds., pp. 46-51, 1997.
[23] H. Corbett and G.B. Rossman, "Three Paths to Implementing Change: A Research Note," *Curriculum Inquiry,* vol. 19, no. 2, pp. 164-179, 1989.
[24] R. Yin, *Case Study Research: Design and Methods,* second ed. Sage Publishing, 1994.
[25] M. Lipman, "Caring as Thinking," *Inquiry: Critical Thinking across the Disciplines,* vol. 15, no. 1, 1995.
[26] D. Passey, S. Williams, and C. Rogers, "Assessing the Potential of e-Learning to Support Re-Engagement amongst Young People with Not in Education, Employment or Training (NEET) Status: An Independent Research and Evaluation Study. Overview Report," Becta, http://partners.becta.org.uk/upload-dir/downloads/page_documents/research/elearning_reengagement_neet_overview.pdf, Apr. 2008.
[27] Roehampton Univ., *Mobile Training,* http://www.roemot.mobi, 2008.
[28] N. Winters, "What Is Mobile Learning?" Big Issues in Mobile Learning: Report of a Workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative, LRSI, Univ. of Nottingham, pp. 7-11, 2007.
[29] A.T. Henderson and K.L. Mapp, *A New Wave of Evidence: The Impact of School, Family and Community Connections on Student Achievement,* Southwest Educational Development Laboratory, 2002.
[30] S. Wolfendale, "Department for Education and Skills Discussion Paper for TeacherNet—Working with Parents. Getting the Balance Right: Towards Partnership in Assessing Children's Development and Educational Achievement," http://www.teachernet.gov.uk/_doc/7302/ACF952.doc, 2004.
[31] E. Hartnell-Young, "Mobile Phones for Learning in Mainstream Schooling: Resistance and Change," *Proc. World Conf. Mobile and Contextual Learning 'The Bridge from Text to Context' (mLearn '08),* J. Traxler, B. Riordan and C. Dennett, eds., pp. 160-167, 2008.
[32] B. MacGilchrist and P. Mortimer, "The Impact of School Development Plans in Primary Schools," *School Effectiveness and School Improvement,* vol. 8, no. 2, pp. 192-218, 1997.

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