Chapter 2
Seamless Learning Despite Context

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Abstract The chapter examines seamless learning, where the aim is to enable a continuous flow of meaning-making despite changes in the physical and social context. One way to achieve this is by inducing a flow state such that learners are so engaged in a mobile learning activity that they lose awareness of their surroundings. Mobile educational games may be one way to achieve such flow, but this is neither easy to achieve nor necessarily effective for learning. Another approach is to connect learning across contexts such as classroom and home. This approach requires careful orchestration of the learning, to enable the learning in one setting to be integrated into another. Seamless learning despite context is a fundamental skill that integrates self-directed learning, teacher guidance, and the support of a mobile technology toolkit.

Introduction

Context has become a central theme of research and development in mobile learning. Until now, work on contextual mobile learning has focused on how to deliver educational materials that are relevant to the learner's location, for example, in a museum (Lonsdale et al. 2004), a heritage site (Huizenga et al. 2009), or on a field trip (Verdejo et al. 2006). Or it has examined how to connect the learning that takes place in a classroom with learning outdoors (Vavoula et al. 2009; Adams et al. 2011). Or the research has examined context more broadly as a basis for design of mobile learning (Boyle and Ravenscroft 2012) and as a relationship between learners, technologies, and society (Traxler 2007). What none of these approaches to mobile learning has addressed is how to maintain a seamless continuity of learning despite the changing physical and social context.

Seamless learning can be defined as a continuity of the learning experience across contexts (Chan et al. 2006). This is best seen as an aspiration rather than a bundle of activities, technologies, and resources. In a 1996 paper introducing the concept, Kuh proposes that what were previously distinct experiences of learning

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(in-class and out-of-class; academic and non-academic; curricular and co-curricular; on-campus and off-campus) should be bound together so as to appear continuous (Kuh 1996). This learning may be intentional, such as when a teacher-led learning activity starts in a classroom, then continues as homework. It can also be accidental, for example, when an interesting piece of information from a newspaper or television programme sets off a learning journey that leads to exploration, discussion, or formal learning. Although the learner may be aware of context at any point in this journey and may benefit from contextual resources, the overall experience is of abstracting from specific times and locations. At its most successful, a learner may be able to experience a flow state of continual engagement with a topic (Csikszentmihalyi 1990) regardless of the passing time and changing surroundings.

This relates to the notion of autotelic (or self-motivating) learning (Moore 1959) in which the learner has an intrinsic desire to continue learning, such that the process of finding out is its own reward and the learner is motivated to accrete knowledge by exploring immediate ideas and surroundings. ‘The most important attitude that can be formed is that of the desire to go on learning’ (Dewey 1938, p. 48).

As Kuh indicates, such a self-motivated flow of learning rarely happens spontaneously; the individual learning experiences must be ‘bound together to appear whole and continuous’ (Kuh 1996, p. 136). Who will do the binding, and how? The responsibility could lie with the learner to initiate and maintain the flow of learning across contexts, with a teacher to guide and support the movement of learning from classroom to out-of-class, or with technology that enables learning activities to be initiated, suspended, and then rapidly restarted, or from a combination of these. In this chapter I shall explore the notion of seamless learning despite context, drawing on examples of previous mobile learning projects, from the perspectives of technology developer, learner, and teacher.

The Flow of Learning

The psychologist Mihaly Csikszentmihalyi has studied how people become absorbed into a flow of activity such that time and surroundings recede:

> You’re right in the work, you lose your sense of time, you’re completely enraptured, you’re completely caught up in what you’re doing…. There’s no future or past, it’s just an extended present in which you’re making meaning… (Poet Mark Strand, quoted in Csikszentmihalyi 1996, p. 121).

A similar state of optimal flow can sometimes be achieved for learning, but such a state of absorption, engagement, fulfilment, and progress is at odds with a typical classroom where the task is set by the teacher, there are continual distractions, and time is compartmentalised into 40 min periods. Figure 2.1 shows the nearest to a classroom state of flow. The children are working at laptop computers with touch screens and the task for each child is to write a summary of books read over the previous week, then to draw a picture on the computer screen that illustrates the

Fig. 2.1 Children in a Taiwan elementary school absorbed in a writing and drawing activity on mobile devices

book. The summaries are then stored on the school intranet and the children can read and rate each other's work. When a group of academic visitors arrived and walked round the classroom taking photos, the children barely glanced up and none spoke. Such silent focus on the task is, perhaps, more a consequence of the Taiwan education system than the personal technology; however, the devices provide both a medium of expression and a means to coordinate the learning activity.

Csikszentmihalyi (1996) proposed nine indicators of a flow state that are equally applicable to the flow of learning:

– There are clear goals every step of the way.
– There is immediate feedback to one's actions.
– There is a balance between challenges and skills.
– Action and awareness are merged.
– Distractions are excluded from consciousness.
– There is no worry of failure.
– Self-consciousness disappears.
– The sense of time becomes distorted.
– The activity becomes 'autotelic' (it is done for personal satisfaction).

In a flow state, the student is engaged in an overarching context where they are impervious to physical, temporal, social or technological changes. Designers of educational technology need to understand how learners enter such a flow state, how it can be maintained despite the changing setting, and whether it can contribute to effective learning.

Flow and Computer Games

As regards mobile technology, the obvious parallel is with computer games. These are deliberately designed to promote a state of flow and continuous engagement, by setting clear goals, providing immediate feedback, balancing challenge and skills, merging action and awareness, limiting the effects of failure and suppressing distraction. In his classic work on what makes computer games fun to learn, Malone (1980) refers to Csikszentmihalyi in analysing the intrinsically motivating aspects of computer games.

Since then, designers of learning technology have attempted to ‘gamify’ educational software, by engineering challenge, curiosity, and fantasy (Malone 1980) and by deploying the mechanics of gameplay to enhance learning (Habgood and Ainsworth 2011; Reeve 2012). When such game-based learning is implemented on mobile devices, the aim is that people of all ages might experience a seamless flow of learning across space as well as time.

This is one vision of seamless learning: people so engaged in a mobile learning activity that they lose awareness of their surroundings. Yet this is neither easy to achieve nor necessarily desirable in practice. The easiest way to create a flow of mobile learning is through a narrative such as an educational video or podcast. A study by Evans (2008) indicated that university students find podcasts to be more engaging and effective than textbooks for revision, but there is a lack of evidence that they improve initial learning (Heilesen 2010). The same is true for ‘flipped classrooms’ where students can watch video lectures, at home or on mobile devices, and then work on assignments, labs, and tests in class. While the home or mobile activities may be engaging, they deliver lectures by another medium and ‘an overwhelming body of research shows that students do not learn effectively from lectures’ (Twigg 2004). The more that mobile lecture delivery is modified to try and improve learning effectiveness, for example, by allowing students to stop and rewind the video, or to take notes, the less the learning is continuous and uninterrupted. There is no evidence that providing a continual flow of learning material will result in effective learning, and the learner should not just stop and start the flow of learning but control and guide it.

Another route to seamless learning is to make interactivity an intrinsic part of the educational experience so that the learning content is integrated with the mechanics of the gameplay (Habgood and Ainsworth 2011). In Habgood’s game of Zombie Division, children learn the mathematics of dividing numbers through a video game where zombies appear with numbers on their chests and the player must choose an appropriate weapon to ‘divide’ the zombies (Fig. 2.2). For example, a zombie carrying the number 12 can be killed with a weapon of 2, 3, 4, or 6 blades. In one of the few comparative studies of game-based learning, Habgood found that the version of the game where flow and reward were integrated with the teaching resulted in significantly greater learning gains than a version where the teaching content and the gameplay were separated. Although Zombie division was developed for desktop devices, the same principles can be applied to mobile educational games. Designing such a ‘flow-learning’ game is not simple: Habgood is a professional computer game designer and the work was carried out over the 3 years of a PhD.

Fig. 2.2 Screenshot from Zombie Division (Habgood 2007)

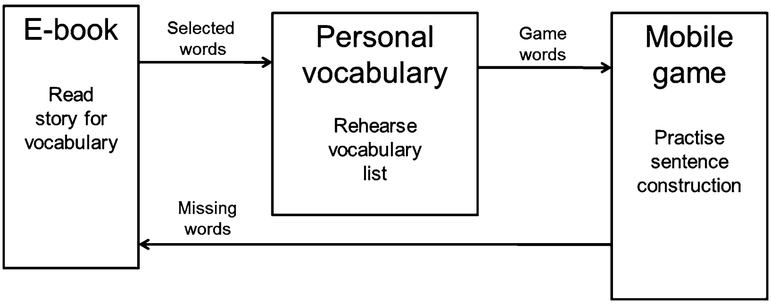

Fig. 2.3 The flow of activity in Elmo between e-book and game

Another attempt to create a seamless flow of engagement between mobile learning and gaming was the Elmo project. It objective was to help non-native speakers of English to acquire vocabulary through incidental learning rather than direct instruction. Figure 2.3 shows the flow of activity. Each page of an illustrated electronic book displays highlighted words matched to the learner's reading level.

The learner can click on words to get further information and practice, such as hearing a pronunciation or drawing a picture of the word. Each of these selected words is stored in the learner's personal vocabulary list. At any point the learner can switch to a visual game where the aim is to solve puzzles by forming sentences in English to guide a cartoon dog (Fig. 2.4). The puzzles are related to the content of

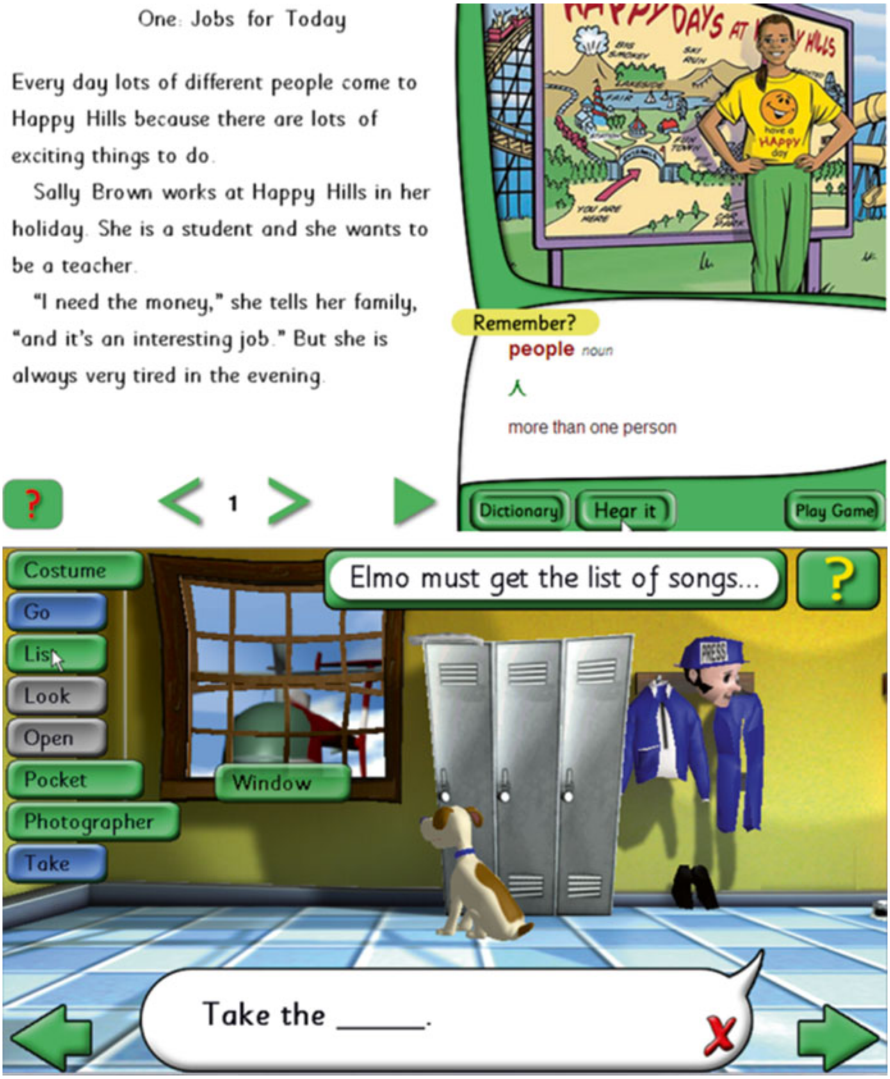

Fig. 2.4 Screenshots from the Elmo e-book and game

the book and only words previously collected by reading the book can be used to guide the cartoon dog. When the learner reaches an impasse in the game, she can switch to reading the book and collect more words. When the learner wants to practise using the vocabulary, she can switch to playing the game. An application for Android phones based on the Elmo approach of adaptive vocabulary learning from e-books linked to game practice (though of individual words rather than sentence construction) is marketed in Japan as Tadoku Academy (http://www.facebook.com/tadoku.academy).

For the learner, there are clear benefits to maintaining a flow of learning on mobile devices despite changes in context. However, the technical and educational issues are raised to a higher level than with contextual mobile learning on a single device. In flow learning, the technical challenge is to maintain a continuity of learning experience across changing devices, times, locations, and social interactions. This is being addressed through cloud computing, where the learning software application is stored and managed on a remote server, with the learner having access over mobile networks on a variety of devices. Software development environments for cloud computing, such as the Google App Engine (Google 2013), enable web applications to be run across multiple servers and accessed on multiple machines.

The educational challenge is to enable a seamless flow of activity that supports satisfying and effective learning. Yet, while there is some evidence that flow induces satisfaction, there is no clear evidence of a relation between flow and learning effectiveness. Hassell and colleagues (2012) studied learning in the virtual world of Second Life. They found that those students who experienced higher levels of flow and ‘presence’ (immersion in the game world) were more satisfied, but not necessarily more effective as measured by a quiz on the learning content at the start and end of the game.

Perhaps, as Pelletier (2009) concludes from her study of children designing their own computer games, the most effective learning is not *about* games or their content, but comes *through* a continuing process of designing and playing game-like activities. For her PhD studies, Roy et al. (2009) ran game design workshops with peer educators in the ‘males having sex with males’ community in Kolkata, India, to develop a collaborative game on mobile phones based on simulated challenges and role-play scenarios. The mobile technology enabled the participants to engage with a shared educational game despite their differences in background, ability, and location. But the learning did not come primarily from engaging with the game content, but through the design process and from discovering that mobile phones and text messaging could be a means to keep in touch and share work experience across contexts.

We need to find new ways to enable learners, individually and collectively, to follow their learning desires and to support them in a continued process of meaning-making, by providing appropriate resources and tools whenever they are needed, by allowing a learning activity to be suspended and resumed, and by harnessing the power of social interaction across contexts.

Connected Learning

Another approach to seamless learning despite context is to connect learning across locations and settings. This is not an alternative to flow learning, but can be seen as a way to supplement it, by offering opportunities to link together activities that have occurred at different times and places. As people move through time and space, only some points will be relevant to their learning goals; so these should be connected while suppressing the less relevant intervening activities. A familiar example is school homework, where the teacher sets a task in the classroom and expects it to be completed at home, with the results brought back into the classroom for marking. What happens in between is irrelevant. For homework, it is sufficient to have instructions to carry home and a written assignment to take back to class.

With mobile technology, the opportunities for connected learning can be extended from written tasks to exploratory and inquiry-based learning. By using a mobile device (such as a smartphone or tablet) as a scientific toolkit, the learner can perform experiments or collect information in one location that can be analysed, shared, or presented in another. Two mobile learning projects illustrate this approach.

The MyArtSpace project (Vavoula et al. 2009) addressed the problem of how to connect informal learning on a school visit to a museum or gallery with teacher-led learning in the classroom. The project engaged 3,000 children and 3 museums over 13 months. In a pre-visit lesson, the teacher introduces the museum and proposes or negotiates a question to guide the visit for each child. For example, on a visit to the D-Day Museum in Portsmouth (which commemorates the Allied landings in the Second World War), a question might be 'Were the landings a success or a failure?' The children visit the museum and collect evidence using a pre-loaded application on a mobile phone. They can hear pre-recorded audio presentations of exhibits, take photos, record commentaries, and make notes. These are automatically sent by phone connection to the child's personal webspace. Then, in a subsequent classroom activity, the children individually or in groups create presentations that address the guiding question.

The Personal Inquiry project (Anastopoulou et al. 2012) had a similar pedagogy of inquiry-based learning within and outside the classroom, with the difference that each child was loaned a personal netbook computer with software to guide the classroom and outdoor learning. In a typical investigation, children addressed the question 'Is my diet healthy?' by compiling a photo diary of the food they ate over 3 days, with the inquiry toolkit assisting them to calculate the nutritional content of the meal and relate it to typical requirements for children of their age.

Both projects were successful in extending school learning outside the classroom. A basic measure of success for MyArtSpace was that the average time the students spent engaging with the museum was 90 min compared to 20 min for a typical school visit. The Personal Inquiry project enabled children to carry out an entire inquiry cycle of forming a question, collecting real data, and sharing and presenting results.

From the learner's perspective, the main difference was that the children used the same device within and outside the classroom for personal inquiry, whereas for MyArtSpace they were loaned smartphones in the museum and the data were sent to a webspace that they could access by password. Each had its advantages. Having a personal webspace meant that the MyArtSpace children could view the results of their museum trip at home and share them with parents. By contrast, the children in Personal Inquiry could carry an inquiry toolkit with them between school, home, and outdoors. Recent developments in tablet technology and cloud computing now offer the best of both, in that a learner can carry a device that acts as a scientific toolkit (with camera, voice recorder, notebook, position locator, tilt sensor, compass, accelerometer, etc.) connected by mobile network to a personal data store and webspace.

A difficulty for both approaches is in connecting the outside activities back into a classroom lesson. The learner must rapidly re-establish understanding that has been gained in an outside context in the very different setting of a classroom lesson. During the MyArtSpace project, children sometimes found it difficult to remember where and why they had taken pictures or how these related to the guiding question. They needed support to recall one context (the museum) within the framing of another (the classroom). This could either be done by de-contextualising the activity, for example, by asking children to collect data that are analysed by their intrinsic properties (as in the food diary where the data related to the content of the meal, not where it was eaten), or by providing additional technology (such as GPS location or an annotation facility) to enrich the results with additional contextual information.

Unlike a typical homework assignment, the results of the outside learning are not presented to the teacher for marking but are used as the basis of a classroom activity. The teacher must conduct a lesson around whatever findings the children bring at the start of the lesson. This disciplined improvisation (Sawyer 2004) can be demanding of a teacher, but can also be a source of productive learning as the teacher explores connections between the brought data and the inquiry question, or extracts general principles from the results.

The learning can come from unexpected results: for example, in an inquiry to study the effect of noise on bird feeding in the school playground, the children collected data that confounded their predictions that birds would eat more food in quiet areas of the grounds. The children then set up a webcam in the grounds and found that food was being eaten by a greedy pigeon that was unaffected by noise. Learning can also arise from failure. In MyArtSpace, children typically collected so many pictures and recordings that they were unable to organise and present them back in the classroom. The teacher was able to use this as an opportunity to discuss the importance of being selective in collecting data.

Orchestration of Learning

The examples of disciplined improvisation in the previous section raise two important issues related to seamless learning: the additional burden on the teacher and the need to structure and support a continuity of learning despite the changing context. In the Taiwan 1:1 classroom, shown in Fig. 2.1, the learning was tightly constrained so that each child was performing a similar, well-understood, task in a familiar setting, with each child operating an individual computer programmed to support a specific task. The primary role of the teacher was to supervise the flow of activity, occasionally answering a child's query. Figure 2.5 shows the flow of activity and communication between teacher, students, and technologies.

As the context of learning becomes less predictable and constrained, for example, in a classroom where each child is equipped with a tablet computer for all lessons, then there is an increasing need for the teacher to manage both the lesson activity and the technology. If the technologies and the activities span time and location,

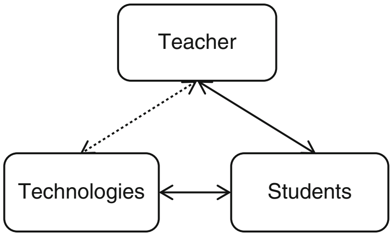

Fig. 2.5 Flow of activity and communications in a constrained 1:1 classroom

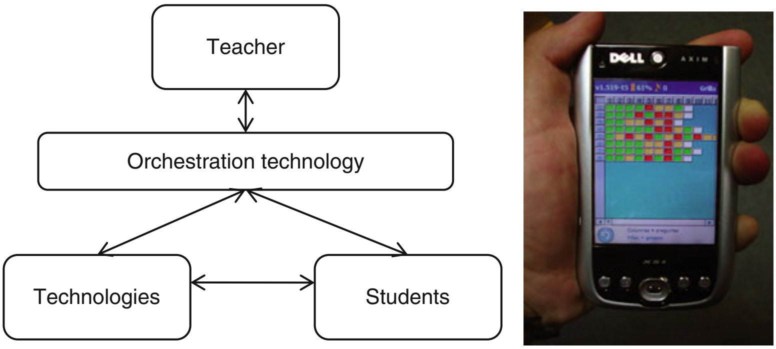

Fig. 2.6 Orchestration technology in the classroom (Picture from Nussbaum et al. 2010)

there is even more need for effective management. The metaphor of 'orchestration' has been proposed to describe the design and management of a learning activity by a teacher in real time, assisted by personal technology (see Dillenbourg and Jermann (2010) for an overview).

Both the MyArtSpace and Personal Inquiry projects identified orchestration of learning as the central issue in supporting a pedagogy of inquiry-based learning that encompassed teacher-initiated inquiry in the classroom, learner-managed investigation at home or outdoors supported by mobile devices, and group activity back in the classroom to synthesise and share findings. Both projects identified the issue of managing a seamless transition from classroom to home or outdoors and back again, by describing clearly the task to be performed and then integrating the results of the out-of-class activity back into a lesson.

Figure 2.6 shows one way of orchestrating learning on mobile devices. The teacher is equipped with technology to view and manage the flow of activity. For example, the Eduinnova system developed by Nussbaum and colleagues provides a handheld 'dashboard' (Fig. 2.6, right) for the teacher to see the activities (columns) performed by the students (rows) as the progress over time, with green marking successful completion, amber showing repeated attempts, and red an incorrect answer. The teacher can also set new tasks and record marks using the handheld software. While this 'fly by wire' teaching classroom may work for some well-structured classroom activity, the reality is generally more complicated, with the teacher also engaged in direct discussion with the students, the students talking with

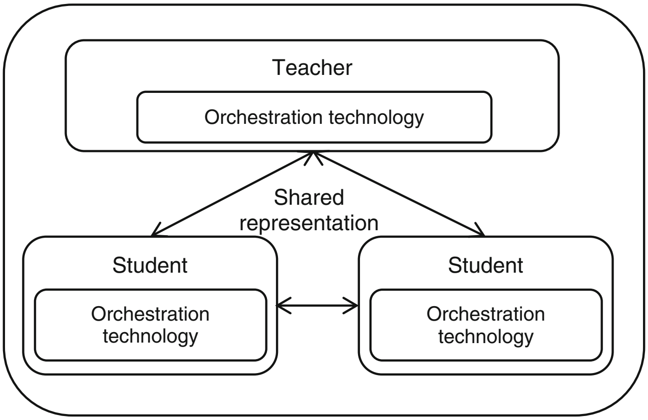

Fig. 2.7 Orchestration technology for seamless learning

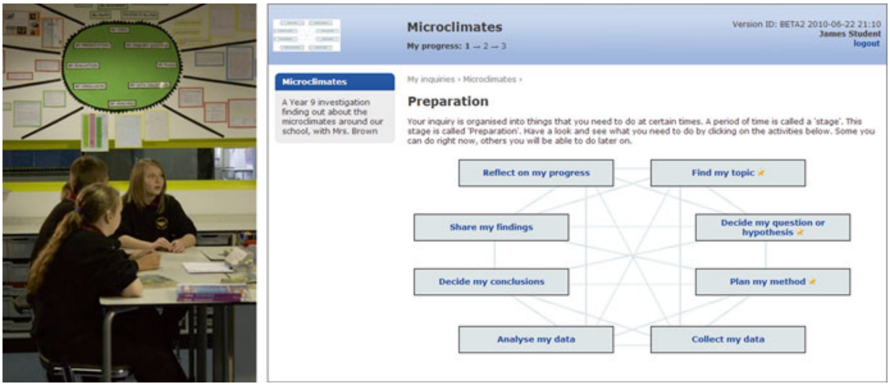

Fig. 2.8 Representation of the inquiry process in the classroom and on the nQuire screen

each other, and the teacher intervening to solve technical problems. Take this outside the classroom, for example, on a museum visit where the students are distributed around the building and the teacher-managed orchestration may become complex and fraught.

An alternative is to share the control more evenly amongst teacher, learner, and technology. Figure 2.7 shows the orchestration for the Personal Inquiry project. The teacher and the students have identical netbook computers, running the nQuire inquiry learning software, with the teacher's device connected to the classroom smartboard. The aim is to engineer a seamless transition not only across contexts but also forms of orchestration (Anastopoulou and Sharples 2012).

The project developed a shared representation of the inquiry process that functions in the classroom as a guide to science inquiry (Fig. 2.8 shows it used as a classroom wall display) and on the nQuire screen as links to manage the series of inquiry science activities.

The nQuire software works as a personal inquiry management system. Within the classroom, the teacher orchestrates the learning, by introducing a theme then proposing or negotiating with the children the specific questions to explore. For example, within the theme of Healthy Eating, an inquiry question might be 'Is my daily diet healthy?'

The teacher then passes control to the software, which forms the children into groups and assists them in planning their method of investigation. In class, the groups of children form a collective plan and decide on the method of investigation. Then, the learning continues outside class, orchestrated by the nQuire software. Each child individually interacts with the software to carry out the activity and collect data. In the example of the healthy eating inquiry, this consisted of each child taking photographs of every meal over 3 days, uploading each photograph to nQuire, selecting the food items from a simple pre-prepared list (e.g. '1 portion cereal', '1 portion milk'), and viewing a bar chart of the nutritional content of fat, carbohydrate, vitamins, etc. Lastly, back in the classroom, the software synchronises the data and children work in groups to compare the results with each other and with the recommended nutrition levels for children of their age. The teacher resumes orchestration of the classroom group activity.

The software does not fix the order of tasks and the children can move backwards and forwards through the inquiry process, to view future activities and to revisit previous ones, such as revising the inquiry question. It manages a continuity of learning across contexts and handover of control from teacher, to groups, to individuals, and then back to groups and the teacher. It also connects and constrains activities across time; for example, the 'decide my conclusions' activity re-visits the initial questions and asks the learners to answer them based on their analysis of data. The aim is to enable a seamless handover of learning management from the teacher to the student-with-computer, and also to support a seamless flow of control across activities.

Software alone will not solve the difficult problems of how to maintain a seamless flow of learning despite changes in context and control. The children need to be carefully prepared for individual work outside the class, so that they do not go 'off track' (metaphorically or literally) and engage in excessive collecting or irrelevant activity. The teacher has an additional burden not only of managing a process of open inquiry but also of orchestrating a demanding classroom lesson involving disciplined improvisation in order to synthesise the findings and draw meaningful conclusions. Finding an appropriate balance of orchestration between learners, teacher, and technology is a fundamental element of the new ecology of mobile learning that bridges formal and informal settings.

Conclusions

Taking a broad view, Wong and Looi (2012) propose that seamless learning is more than a set of novel educational practices; it requires a change in the culture of education to incorporate mobile learning into the curriculum and to equip children with the meta-cognitive abilities that allow them to relate learning that occurs as part of daily life to the knowledge and skills they have gained as part of formal education. The ultimate aim of seamless learning, Wong and Looi propose, is to enable people to engage in productive self-regulated learning that spans times, locations, devices, and tasks.

It is undoubtedly valuable that children should learn at an early age that learning can occur anywhere and that knowledge formed in one setting can be applied in another. For this to happen, they need to learn when knowledge is contextualised – bound to the place, time, or social settings where it occurred – and when it can be abstracted to form general principles that can be applied elsewhere. They also require conceptual and technical tools, for sense-making and reflection, to continue the flow of learning as they move through time and place. These abilities need skill and practice to develop, so the teacher will remain essential in helping young people to make deep sense of the world despite the changing context.

Take, for example, the Healthy Eating project activity that the children carried out as part of the Personal Inquiry project. The teacher had an essential role in framing the investigation, elaborating the concept of healthy eating, introducing the elements of diet such as vitamins, protein, fat, and carbohydrates, and showing how the food intake for a day can be related to typical levels for a child. All these teacher-led activities prepare the children for seamless learning despite context, so that as they keep daily food diaries they know *how*, *why*, and *where* they should be carrying out the activity (e.g. how to recognise nutrition content from food labels despite differences in packaging) and can make sense of their findings. In the subsequent classroom lesson, the teacher has a role in helping to integrate and interpret their findings despite the differing contexts in which they collected the information. Each child is using the mobile technology to make sense of a fundamental concept across changes in context, and the teacher offers help and support to frame, regulate, and integrate the learning. Seamless learning despite context is a fundamental skill that can be best gained through a combination of exploratory sense-making, self-regulation, mobile technologies for data collection and visualisation, and a teacher trained in methods of inquiry-led learning.

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