

The challenge of supporting networked personal inquiry learning across contexts

Eileen Scanlon, Lucinda Kerawalla, Mark Gaved, Ann Jones, Trevor Collins, Paul Mulholland, Canan Blake, Marilena Petrou, Karen Littleton

Institute of Educational Technology, Open University, e.scanlon@open.ac.uk

Abstract

Supporting learning across different contexts can be challenging. Defining formal, informal and non-formal learning is the subject of continuing debate as each can be difficult to describe. We report on a study that evaluated the effectiveness of a Personal Inquiry toolkit on supporting personal inquiries into the sustainability of the food cycle, carried out across the contexts of home and an after school club in a UK secondary school. The toolkit consisted of a web-based Sustainability Investigator that could be accessed from any location, together with a selection of data-gathering tools such as environmental sensors (e.g. temperature probes) and cameras. It was designed to support students through the process of carrying out inquiries within the club and between the club and their home. Our main focus here is on describing how the Sustainability Investigator supported students' inquiries that were conceived and designed within the club and conducted at home. The 30 students (aged 12-14 years) chose to investigate home food storage, packaging and preservation. Our focus is on exploring the nature of the semi-formal club context and how this mediated students' use of the Sustainability Investigator. Analysis of our field notes, log files of students' use of the Sustainability Investigator, together with video and audio recordings of club sessions and interviews with teachers and pupils, suggest that while the pupils' use of the toolkit across contexts was sporadic and varied between students, they successfully completed personally relevant inquiries and developed positive attitudes to the process. This was different to the predictable, sustained and consistent use of the toolkit identified in our previous studies when the students used it (again successfully) to support their inquiries in a formal classroom setting (see e.g. Scanlon et al. 2009). Three main features of the school club context that mediated the ways in which the Sustainability Investigator was used by the students across contexts were: 1) the students' aims and priorities, 2) affordances and constraints of the technology, and 3) institutional priorities. We use this example of a study of learning across contexts to suggest implications of the work for the potential of a Personal Inquiry toolkit to support learning across the life course.

Keywords

Learning across contexts, Semi-formal Learning, Inquiry Learning

Introduction

The Personal Inquiry (PI) project, funded by the Technology Enhanced Learning Program, is a three year joint activity between the Open University and University of Nottingham (<http://www.pi-project.ac.uk/>). It is researching how students can be helped to learn the skills of evidence-based inquiry (Collins *et al.* 2008). We are particularly interested in how technology can be used to enhance learning across formal and informal settings. A key issue for the project is how to design support for evidence-based inquiry learning using a 'scripted inquiry learning' approach. We are working with children between the ages of 12 and 15 who are conducting a range of inquiries in science and geography. We have produced a personal inquiry toolkit. This toolkit, running on a mini-laptop, provides 'scripts' that guide the learners through a process of gathering and assessing evidence and conducting experiments on topic themes of relevance to the UK National Curriculum. The toolkit consists of a range of scientific data gathering equipment such as Sciencscope sensors and cameras plus a web-based application that supports students' progress through the stages of the scientific inquiry process (named Sustainability Investigator for the current study, in response to a teacher's request, and will be referred to as such in this paper).

Over the past two years over two hundred students have been involved in a range of inquiries as part of the project. These investigations have included students in:

- 1) Investigations on diet: where students made predictions as to the nutritional quality of their diet, testing these by keeping a diary of their meals and snacks and then used these to work out their nutritional intake (Anastopoulou et al., 2009);
- 2) An Urban Heat Islands investigation: where students developed hypotheses on how temperature varies across an urban area, making measurements and observations, and using these to explain variations; (Collins et al., 2008)
- 3) Investigations on Microclimates: where students decided where in the school grounds would be the best locations for different types of activity such as flying a kite, planting a flower garden, or locating a picnic bench, and then collected scientific data at different locations in order to test their predictions (Mulholland et al., 2009).

The design of the Sustainability Investigator is informed by the development of a personal inquiry framework (see Figure 1). We have used this framework as an intermediate representation of the inquiry learning process which underlies the design of our activities. It was developed from our review of the inquiry learning literature, mainly school based studies but also incorporated studies with older learners in higher education (see e.g. Brew, 2003, Johnson, 2009). The together with the results of pilot studies identifying particular areas of difficulty for young people pursuing inquiries (see Scanlon *et al.* (in preparation) for further details). The Sustainability Investigator presents the inquiry process in terms of phases (e.g. Plan my Methods) that consist of associated activities (e.g. Choose my Measures) (see Figure 1 and associated text for more details).

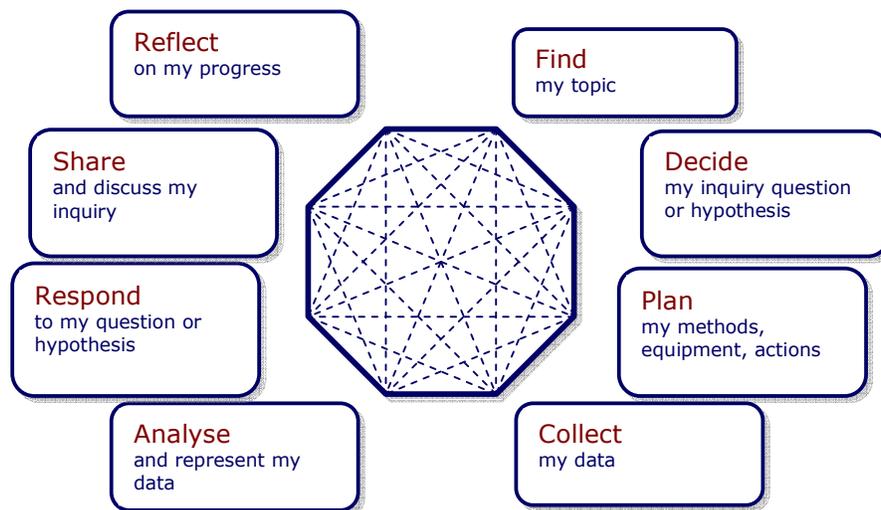


Figure 1: An intermediate representation of the personal inquiry framework

The focus of this paper is on evaluating the effectiveness of the web-based Sustainability Investigator in supporting students in carrying out personal inquiries across the contexts of an after-school club and their home. We report on a study that involved 30 students and 3 teachers who attended an after-school club – Sustainability Club –that aimed to investigate the sustainability of the food production cycle. Important features of the contexts of both the club and the students’ homes resulted in sporadic club attendance and varying degrees of activity being carried out at home, but students successfully completed inquiries and developed positive attitudes to the processes involved in inquiry learning and to the topic of sustainability.

Informal Learning

Vavoula (2004) presents a typology of learning based on the presence of, and control over, the goals and the process of learning (see Figure 2). She defines intentional formal learning as occurring when either the goals or the process of learning, or both, are explicitly defined by a teacher or an institution. She defines unintentional,

informal learning as occurring when the goals of learning are not specified in advance, and there is no prescribed learning process, but they can develop ‘on the fly’ as a learning occasion arises.

However, Colley, Hodgkinson and Malcolm (2002) put forward a strong argument, resulting from a review of several studies, that it is often impractical to define learning as being either formal or informal because in most learning contexts there

is often a degree of ‘crossover’ (McGivney 1999) between the two (see also Scanlon, Jones and Waycott, 2005).

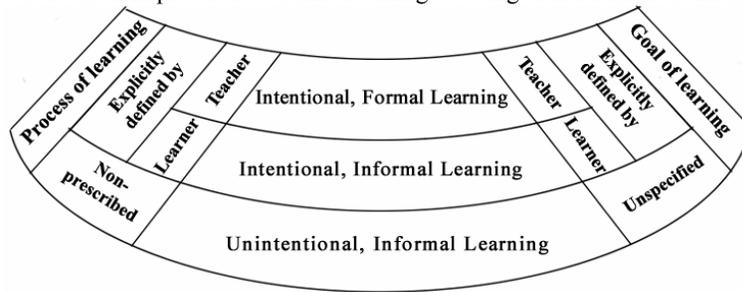


Figure 2: Typology of learning based on the presence of, and control over, the object and the process of learning (reproduced from Vavoula 2004)

For example, teacher control is commonly defined as a feature of formal learning, and learner control as feature of informal learning (see also Figure 2), but Colley et al. point out that informal and formal learning can co-exist within a given context. They conclude that it is more important to explore the different dimensions of formal/informal learning and the way in which they inter-relate with each other in particular institutional contexts than to try to delineate types of learning. Studies reviewed included work with students of all ages.

Use of technologies to support learning across different physical contexts that are constituted by their own local socio-cultural ecologies can be challenging. For example, Kerawalla and Crook (2002; 2005) found that, despite parents’ best intentions, home computers are rarely used by primary children to support their school work because home computers are conceptualised by the family as being associated more with entertainment than with education. On the other hand, tablet PCs that enable young children and their parents to access identical software and learning materials that have been used in the classroom, to support the completion of formal homework tasks, can be successfully appropriated into the family (Kerawalla et al., 2007). Anastopoulou et al. (2007) report on a study (carried out as part of the current project) in which secondary school students were required to carry out a personal inquiry into their own dietary intake with a view to addressing their own predictions about the nutritional content of their own diets. The students were asked to keep food diaries and take photographs of what they ate at home, and to discuss them in class. The researchers found that many of the children were reluctant to discuss what they had eaten, or to take photographs of foods that they thought their class would consider as being unhealthy; they felt the inquiry was too personal or invasive. All of these examples focused on the use of technologies to bridge informal (home) and formal (school) contexts and they all required a degree of transfer of the materials/resources/decisions/aims generated in the classroom, into the home. In the case of the latter two studies, activities initiated in the classroom were required to be completed at home, and completed work taken back into the classroom. In this sense, we argue that it would be unrealistic to draw a firm line between the informal home context and the formal classroom context as there is clearly a large degree of ‘crossover’ and mixing not only in terms of resources etc but also in terms of the types of learning that takes place across contexts. Although these studies have involved school children the requirement to learn across a range of contexts is common to learners at all levels. It is the inter-relationships between the contexts of an after-school club and students’ homes that is the focus of the current study, as a means of understanding how the Sustainability Investigator could support learning across contexts. Our research was designed to investigate to what extent the Sustainability Investigator was effective in supporting personal inquiries across the contexts of an after-school club and the students’ homes and which contextual features played a role in mediating the extent to which the students engaged in personal inquiry activities.

Methodology

Teachers in a secondary school in central England invited around 40 students (aged 12-14 years) to join the Sustainability Club and a further 10 students (of similar age) asked to join of their own volition. Invitations were made to students who the teachers knew were particularly interested in Geography, and those who regularly carried out extra Geography work in their own time. It was expected that approximately 30 students would

attend the club although the teachers stressed that attendance was voluntary and indicated to us that attendance at any school club was often sporadic. Three teachers were involved in this study. We had worked previously with all of them on other formal classroom studies related to the PI project. One of these teachers was the Head of Geography and she gradually withdrew her attendance and adopted a more facilitatory role once the other two junior teachers, who were involved in an after-school club for the first time, had gained some experience. The club was attended by 5 researchers: 2 or 3 offered technical support during each session, two video recorded the activities of one focal group of students each, and one took field notes. Participation in club activities varied and is discussed further below.

The club: aims and activities

The club was held immediately after school for one hour one day per week. It was held in a variety of rooms (a club room containing no technology, a classroom with an interactive whiteboard, and an ICT suite), depending upon the technological needs of the club activities (e.g. watching a video, working on paper-based activities, working on a desktop computer or Asus mini-laptops). We held several meetings with the teachers to discuss plans for each club session. The aim was to encourage students to select an animal or plant-based food and to carry out personal inquiries into each phase of the food production cycle, defined by the teachers and illustrated in Figure 3.

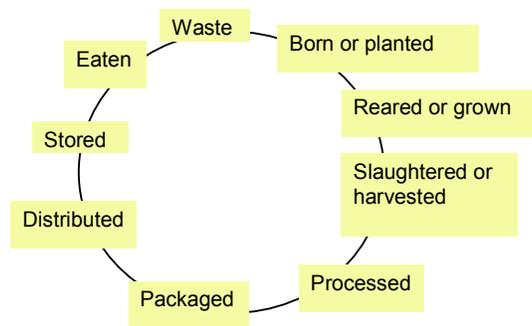


Figure 3: Food cycle

We decided to use Kellett’s (2005) ‘thought bubble’ approach to hypothesis generation and inquiry design to support the students in designing an experiment that they could carry out at home to increase their understanding of one phase of the food production process. This approach was successful in generating plans for home investigations into the storage and decomposition of various foods, such as packaged/unpackaged ‘value’ and ‘fair trade’ bananas. Alongside these investigations, students were expected to carry out internet searches to gain understanding of other features of the food production process with regard to their chosen food. During the meetings with teachers it was decided also that the Sustainability Investigator should support the collection of qualitative data sets, such as interviews and photographs, as well as quantitative data such as temperature and humidity readings. Further details of support offered by the Sustainability Investigator are given in the next section.

The Sustainability Investigator

The students had the option to take home Sciencescope sensors to enable them to record some of atmospheric conditions in which their chosen food was stored and observed to decompose. Humidity and temperature sensors were made available, along with digital stills cameras. There was also the option of borrowing a small handheld video recorder (Pure Digital Flip or Creative Vado) for video diaries. Each student was loaned an Asus Eee 701 PC wireless enabled mini-laptop for use in the club and at home. This ran a Linux operating system and contained by default a range of software to support, for example, word processing, spreadsheets, multimedia creation and viewing (the laptops have built in webcams) and game playing. The laptops, along with home and school computers, could be used to access the web based Sustainability Investigator (SI) running from a server hosted by the Open University. The SI was adapted from previous studies (e.g. Scanlon et al., 2009) and designed by this project to support the students’ personal inquiries into food sustainability at the club, including a home based experiment.

The SI supported pupils through the phases of the inquiry by a menu bar that appears on the left of each web page (see the enlarged menu bar on the left of Figure 4). This inquiry, devised in collaboration with the students and teachers, was broken down into 5 phases, each of which contained a range of activities. A second inquiry was devised to enable students to interview their friends and family to gather opinions about issues related to food sustainability. Each group of students could access the two SIs: one for home interviews and the other supporting their food storage, packaging, and preservation investigations. Figure 4 illustrates the main features of the SI designed to support the food storage, packaging, and preservation investigations. On the menu bar, the phase ‘Topic’ (in the light grey box on the left in Figure 4) links to a number of activities, presented as individual web pages containing structured guidance and text boxes into which the students can type their hypothesis and findings from their research on each of the elements of the food production process. ‘Method’ links to activities in which students can 1) select measures (e.g. smell or temperature) from a list that they had previously identified and collaboratively authored in the SI with the research team including the defining of units, collection times and frequencies, and data type (e.g. numerical or text), and 2) add any new measures they choose. ‘Data collection’ links to an “Add Data” activity, presenting the students with a blank data collection form generated from the measured defined and co-authored by the students previously, enabling students to gather multiple data points over the duration of the investigation (e.g. twice a day for a week). Each completed data point will then be presented to the students in this phase so on returning to the Data Collection phase the students will be able to add additional data points or review (view or edit) existing collected data points. The ‘Results’ phase in this inquiry offers an “Add Results Table” activity, displaying a list of the measures that the students have been collecting. Selecting the measures the students would like to analyse will create an automatically-generated summary data table of all their data points showing these selected measures, enabling comparison and export into a spreadsheet for further analysis where appropriate. ‘Conclusion’ links to an “Answer” activity with a text box in which students can reflect upon whether and how their data supports their hypothesis.

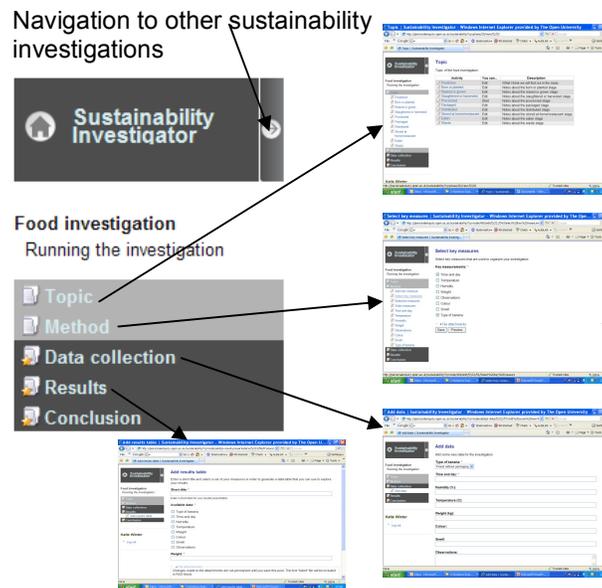


Figure 4: Screen shots from the Sustainability Investigator designed to support the home food storage, packaging and preservation inquiries

Findings

Analysis of our field notes, log files of students’ use of the Activity Guide, together with video and audio recordings of club sessions and interviews with teachers and pupils, suggest that the pupils’ use of the SI across contexts was unpredictable, sporadic and varied considerably between students. Close analysis of our data has enabled us to identify three main contextual features that played a significant role in mediating how the SI was adopted and used by the teachers and students. We discuss these next.

Students' aims and priorities

Attendance at the club was not compulsory nor explicitly encouraged and hence fluctuated; in the first few weeks it increased by around one third but following the half-term break, attendance slowly declined to around forty per cent of the peak. There were several reasons for this: there were other clubs running on the same afternoon that students preferred, there were rehearsals for the school Christmas play and a sports club that several students belonged to, changed to the same day, so students had to leave the sustainability club as they were involved in competitive sports teams that represented their school. After seven weeks, all but two members of one of the focal groups left to attend the sports club. Attendance of each group member fluctuated so groups were incomplete in some weeks and sometimes merged temporarily with others. In their interview, students said that working in groups was “good but lots of people kept joining us in the middle so we had to explain our whole idea...some people would join our group and then not come every week so it was difficult”. This pattern of sporadic working in groups with varying membership is familiar also with older learners.

Student engagement in club activities during club sessions was generally high; home interviews and inquiries were designed with enthusiasm and the students appeared to be enjoying themselves. In the interview, they said that their main aim was to “learn more about sustainability” and one student said she had never heard the term before. Two of the students had previously been ‘eco reps’ [ecological representatives] for their school where they were encouraged to, for example, look after the flower beds and arrange activities. All students spoke positively about the experience of being able to work in a semi-formal environment in which they had more control, responsibility and choice than in normal lessons:

in school you have to learn, but when you *choose* to do something it's meant to be a bit fun...you learn stuff but you're also doing fun stuff as well...and you don't realise that you are doing it. In normal lessons you are just copying off the board into your books...here you get more freedom...it's up to *us* more than it is in lessons...you always have your choice and you can speak out...one of the best things about doing the experiments at home was that we did it for ourselves (comments from several students talking at once have been condensed here).

The degree to which students carried out any club activities at home was varied and seemed to reflect the extent to which their enthusiasm extended to the informal home context, whether they had the time, and whether or not they could find a suitable site at home that could be used to store food that was slowly decomposing. In the focal group that attended the club for a prolonged period, one student carried out the inquiry in her home as she had a cupboard in a garage, which the group felt to be the most appropriate site for storing rotting bananas. Two students reported visiting her home to help and observe progress. They investigated the shelf life of packaged/unpackaged fair trade/value bananas in order to test their prediction that packaged value bananas would last the longest (because they would have been grown with the help of chemical insecticides and fungicides and the packaging minimised damage during transportation). They measured the air temperature several times per day, took photographs of the bananas daily and wrote descriptions of their appearance. However, this group initially created their own spreadsheet for data collection, outside of the Sustainability Investigator, as they changed the data they wanted to collect and did not know how to make changes to their data input forms. Once this had been explained, they uploaded their data to the SI. A second group that was investigating cheese storage used the SI throughout. The focal group said they had learned a lot from the club, including: “we're more sustainable now. We don't buy bananas in packaging...when you go into a shop you just buy what's best for your budget, people don't think about the packaging and how far it's travelled, they just think about what suits them...think before you buy”.

Technological affordances and constraints

On the whole, the students managed the technology well. They were able to use it to support a range of inquiries of different length e.g. investigating claims made in the text on egg boxes and whether there are differences between the various eggs once cooked (an inquiry in 30 minutes) and the longer home inquiries into food packaging, storage and shelf life over several weeks. However, some students encountered some difficulties. Although they understood how to type in the URL of the SI website, initially some students did not realise that they could access the SI using their family computer and thought this could be achieved only using the loaned Asus laptop. Connecting to the internet on the laptops at home involved a different procedure from connection at school and some students found this difficult. They were given written instructions and advice in the club but

to begin with we found a number who had failed to connect at home. As the club continued the majority of students were able to connect at home. We have evidence that some of the reasons students could not access a home connection had social as well as technological causes, e.g. parents not knowing how to connect through an encrypted home connection, settings being forgotten, and parents being unhappy at their children connecting directly without net filtering software. Home use of the SI was varied therefore and this would be simpler for older students.

Institutional aims and priorities

As described above, the club was a mixture of the formal classroom and a more informal setting. The after-school club was a semi-formal context that shared characteristics with both a classroom and any informal out-of-school club context. The students had to wear their school uniform and their general behaviour was expected to be consistent with that expected in normal school hours. However, the teachers did not appear to expect them to be on-task to the same degree as in a formal lesson; several students played some of the games on the laptops, dealt with emails and visited social networking and other internet sites during club time, which was not prevented unless it was disrespectful to a teacher or researcher addressing the whole club, for example. Hence, engagement in club activities was generally not monitored or formally encouraged as it would be in a classroom setting. The teachers were not obliged to follow the National Curriculum; there were no lesson plans, so they could devise a range of relatively unconstrained activities. Also, their role in the club, alongside the researchers, was less well-defined than it had been in previous studies which they had carried out with us. Previously, although involved in lesson planning and activities during the lessons, we had taken the role of observers, whereas in the club it was possible for us to respond to the need to shape activities opportunistically as the work in the club unfolded. The teachers needed to prioritise their formal planning and teaching activities and as the club was after-school it was not part of these priorities. Sometimes there was no club because of other school commitments. Perhaps most important is the finding that despite the club's lack of connection to formal assessment, students found time and enthusiasm for activities which they designed which we consider would apply too with older learners. In summary, the complex and inter-related contextual factors of 1) students aims and priorities, 2) the affordances and constraints of the SI, and 3) institutional features all contributed in various ways to the students' use of the SI.

Conclusion and implications for networked learning

We have reported on a study in which a web-based Sustainability Investigator tool was used by students to support their personal inquiry learning across the contexts of an after-school club and the students' homes. Our analysis of a range of data collected from the club context has identified the main contextual features of the club and how these worked to mediate how the web based Sustainability Investigator was used across the club and home contexts. Our findings support Colley et al.'s (2002) claims that attempting to delineate formal and informal learning can be problematic and that it is more important to explore the different dimensions of formal/informal learning and the way in which they inter-relate with each other in particular institutional contexts. The semi-formal context of the school club that combined, for example, teacher-led and student-led activities within the broader constraints of the over-arching institutional setting was different to the context of the students' homes where students took on the responsibility for instantiating the inquiries planned in the club. At home, the students built upon activities and decisions that they had made in the club and then reported on them in the club the following week. There was a distinct cross-over (McGivney, 1999) of activities and types of learning between contexts. The support for personal inquiries provided by the Sustainability Investigator worked well in this challenging environment, and we consider this promising for developing its use further with older learners.

The Sustainability Investigator was web-based and enabled all members of the group to access all their groups' activities across both club and home contexts. Its use to achieve this was varied, depending on the students' priorities, their technological abilities and the nature of the institutional context in which the club was organised (e.g. there was no formal requirement to complete the activities). However, even though some individual students accessed the SI more frequently than others, it was successful overall in supporting inquiries carried out at a group level, where roles had been informally assigned. Students' interview feedback suggest that they were motivated by being able to design and carry out inquiries of their own choice and that activities in the club have encouraged them to think carefully about, and change, their own food purchasing behaviours.

In this project there has been a recognition that mobile technology offers a way of supporting learning across contexts and that it is less helpful to think of a boundary between formal and informal learning than to consider the spectrum of possible settings in which learning takes place. We have established that personal inquiry learning supported by technology is a productive approach to the development of higher order learning skills even in this challenging informal setting, where students' inquiries were varied and subject to shifts as they developed. This finding is in line with the report on cyber-learning (National Science Foundation, 2008) which argues that the use of networked computing and communications technologies to support learning has the potential to transform learning and its authors particularly 'emphasize the transformative power of information and communications technology for learning from K to grey' (p. 7). We intend in future work to test out further the potential of the toolkit to support inquiry learning across the life course.

References

- Anastopoulou, A., Sharples, M., Ainsworth, S. & Crook, C. (2009). Personal Inquiry: linking the cultures of home and school with technology mediated science inquiry. *Paper presented at the 3rd WLE symposium on mobile learning*. Institute of Education, London.
- Brew, A. (2003). Teaching and research: New relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research and Development* 22 (1), 3-18.
- Collins, T., Gaved, M., Mulholland, P., Kerawalla, C., Twiner, A., Scanlon, E., Jones, A., Littleton, K., Conole, G. & Tosunoglu, C. (2008). Supporting location-based inquiry learning across school, field and home contexts, *Paper presented at MLearn*, Telford.
- Colley, H, Hodkinson, P. & Malcolm, J. (2002). Non-formal learning: mapping the conceptual terrain: a consultation report. Retrieved November 2009 from http://www.infed.org/archives/e-texts/colley_informal_learning_htm
- Kellett, M. (2005). *How to develop children as researchers*. London: Paul Chapman Publishing
- Johnson, E. (2009). Enhancing the learning of bioscience skills for students in Australian universities Available at <http://www.bioscience.heacademy.ac.uk/ftp/events/sltc09/presentations/o25johnson.pdf>
- Kerawalla, L. & Crook, C. (2002), Children's computer use at home and at school: context and continuity. *British Educational Research Journal*, 28, 751-771.
- Kerawalla, L. & Crook, C. (2005). From promises to practices: The fate of educational software in the home. *Technology, Pedagogy and Education*, 14(1), 107-125.
- Kerawalla, L., O'Connor J., Underwood, J., Luckin, R., du Boulay, B., Holmberg, J., Tunley, H. & Smith, H., (2007). The Homework system: Using tablet PCs as tools to support numeracy learning between home and primary school. *Educational Media International*, 44 (4), 289 – 303.
- McGivney, V. (1999). *Informal learning in the community: a trigger for change and development*, Leicester: NACE
- Mulholland, P., Collins, T., Gaved, M, Wright, M, Sharples, M, Greenhalgh, C., Kerawalla, L, Scanlon, E., (2009). Activity Guide: An Approach to Scripting Inquiry Learning. *Paper presented at AIED conference*, Brighton, July
- National Science Foundation (2008). Fostering learning in the networked world: the cyber-learning opportunity and challenge. Retrieved February 2010 from <http://www.nsf.gov/pubs/2008/nsf08204/nsf08204.pdf>
- Scanlon, E., Anastopoulou, S. & Kerawalla, L (in preparation). The scripted personal inquiry approach: using technology to represent and support students' understanding of personal inquiry across contexts.
- Scanlon, E., Jones, A. & Waycott, J. (2005). Mobile technologies: prospects for their use in learning in informal science settings. *Journal of Interactive Media in Education* 21(5)
- Scanlon, E., Littleton, K., Kerawalla, L., Gaved, M. (2009). Blended support for evidence-based inquiry learning: Teachers, tools and phases of inquiry, *Paper presented at EARLI*, Amsterdam, August.
- Vavoula, G.N. (2004). *KLeOS: A Knowledge and Learning Organisation System in Support of Lifelong Learning*. Electronic, Electrical and Computer Engineering. Birmingham, University of Birmingham.

Acknowledgements The project acknowledges support from the Economic and Social Research Council and the Engineering and Physical Sciences Research Council UK Technology Enhanced Learning phase of the Teaching and Learning Research Programme. Our thanks are due also for sensors supplied by project partner Sciencscope <http://www.sciencscope.co.uk> and to the teachers and young people involved in our studies.