PERSONAL INQUIRY: SCRIPTING SUPPORT FOR INQUIRY LEARNING BY PARTICIPATORY DESIGN

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ABSTRACT

This paper focuses on the participatory design processes during a project concerned with supporting children aged 12 – 15 to carry out personal scientific inquiries and in particular how the process varied between two case studies conducted in very different settings but within the same school. The context for the case studies is a three year project on Personal Inquiry: Designing for Evidence-Based Inquiry Learning across Formal and Informal Settings which is being jointly conducted by the Open University in Milton Keynes and University of Nottingham. Our key challenge is to develop support for evidence-based inquiry learning and we are investigating how school students can be helped to learn the necessary skills in both formal and informal settings and how the use of technologies can support them in that endeavour. We have conducted trials involving children carrying out inquiries in science and geography. For these we have developed a personal inquiry toolkit which consists of a range of scientific data gathering equipment, together with web-based software, nQuire, that supports students' progress through their scientific inquiries. This toolkit, running on an Asus Eee netbook provides 'scripts' that guide the learners through a process of gathering and assessing evidence and conducting experiments. Teachers can orchestrate activities by specifying who can progress through a given inquiry and by what means as the availability and content of the activities undertaken by learners during the inquiry can be altered as they progress through the inquiry learning process. So far we have completed seven sets of trials in two schools involving more than 200 young people, with inquiries on a wide range of topics including healthy eating, urban heat islands (twice), microclimates, the link between exercise and heart rate, food packaging, and noise pollution. This paper illustrated using two case studies conducted in Milton Keynes, an early trial on urban heat islands and the most recent trial conducted on food packaging and reports on our approach participatory design in these trials, with particular reference to personalisation.

KEYWORDS

Web-based learning, inquiry learning, m-learning, participatory design, formal learning and informal learning

INTRODUCTION

The need to involve teachers when designing and evaluating technology-based interventions in the classroom, and therefore the need of participatory design (PD), is well recognised in the literature, (e.g., see Good and Robertson, 2006). However, even within one school (and one department) there may be quite a number of features that vary across different contexts in which the technology-based interventions can be used. These features have a bearing on the way in which participatory design is approached and implemented, and upon its success. These features include (but are not limited to): whether the activity is assessed; where it takes place (e.g. field trip, home, classroom); scale (number of children), time span and complexity of the activity; the role of the teacher; the teacher's available time and commitment and the role of the work within the curriculum. We argue here that PD is not a homogenous approach and cannot be applied in a prescriptive way, but needs to be applied in different ways in these different contexts. This paper illustrates this by discussing the approaches taken to participatory design in two very different contexts; both concerned with supporting personal inquiry in Geography in the same secondary school. The first set of activities included a whole year group working in the field and at school and over a long time period to produce a piece of work that would be part of their national assessment. The second set of activities took place within an after school club which was not part of the formal curriculum and therefore not assessed.

DESIGNING FOR EVIDENCE-BASED INQUIRY

The context for these activities is the Personal Inquiry (PI) project (http://www.pi-project.ac.uk/), three-year collaboration between the University of Nottingham and the Open University, UK. This project is funded by the UK Economic and Social Science Research Council (ESRC) and the Engineering and Physical Sciences Research Council (EPSRC) joint program on Technology Enhanced Learning. The aim of the project is to help school students learn the skills of evidence-based inquiry. We are involving young people aged 12-15 years to engage them in inquiry across formal and informal settings in order to understand how effective learning can be enabled with technology across these settings. We are developing an innovative 'scripted personal inquiry learning' approach. By 'scripts' we mean dynamic lesson plans that guide the learners through a process of gathering and assessing evidence, conducting experiments and engaging in informed debate on topic themes (Anastopoulou et al. 2008).

PERSONALISATION

One of the key issues we address in the project is how to make science engaging for young people. Our choice of the term Personal Inquiry is significant in this. Personalisation is a contested term in educational circles but in this project we are interested in engaging young learners in activities which are personally and intellectually relevant to them. We wish to engage learners in activities where they have choice, which they see as relevant to them and which contain elements of learners' responsibility. A government perspective on this is that education should "put learners, young people – and their parents – in the driving seat, shaping the opportunities open to all learners to fit around their particular needs and preferences" (DfES, 2005, 2). In the project therefore we have found it very important to consider how to build learner choices into the design of the inquiries we support. Further details of the individual studies we have done and the learning outcomes for students are given in Anastopoulou et al. (under review) and Kerewalla et al. (under review).

However in this paper we are considering the research question- what role can participatory design play in the construction of support for personal inquiry. Therefore here we compare two case study examples of inquiries conducted in different settings. The purpose of this comparison is to illustrate the different constraints and possibilities in these two settings on making inquiries personal and the ways in which we have approached PD to support this.

THE PI TOOLKIT

The Personal Inquiry project toolkit, which supports inquiry learning, comprises of software and associated hardware. The software nQuire is a web based application which uses a content management system built on a database. Hardware includes data loggers, science sensors and cameras. In the case studies discussed later, nQuire was accessed via a central server at the Open University. However local copies could also be run on the netbook PCs used for fieldwork data collection. nQuire provides support for students by guiding them through their inquiries (see e.g. Figure 1). In different trials, the appearance of nQuire was localised in response to teachers' requests, including appropriate naming, for example "Activity Guide", and "Sustainability Investigator". The design of the support was also informed by the development of a personal inquiry framework incorporating phases of the inquiry learning cycle (see Scanlon et al. under review).

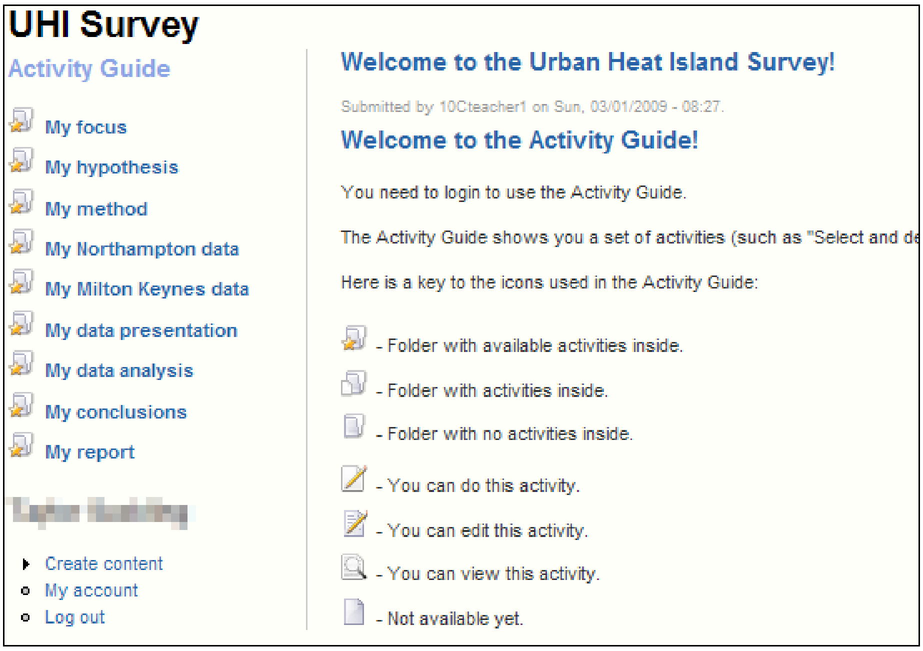


Figure 1. Screenshot from nQuire for the urban heat islands investigation (the "Activity Guide")

THE ROLE OF PARTICIPATORY DESIGN IN PROMOTING PERSONAL INQUIRY

The project has been committed to ongoing engagement by all stakeholders in the design and implementation of the personalised inquiry learning interventions we have developed. Therefore, as part of the first trial (the first case study see details below) we had a series of meetings with teachers during the early stages of the design to decide on the activity and how it would relate to the school curriculum. Through this process it was decided quite early on that the activity would be part of an assessed part of the curriculum on Geographical Information Systems. A key advantage of this was that the planned use of the toolkit would be completely integrated into the curriculum, supporting work that the teachers and students needed to carry out. Chin (2004), in commenting on educational design, argues that this is an important aspect:

'The integration of computer technology and curriculum should be considered during the system development process. Consequently, integration does not only demand that educational technology be effectively applied, but that the technology itself is developed with classroom and pedagogical integration in mind.' (Chin, 2004, 7)

Chin also comments on the important role of the teacher:
'Integration emphasises the central role of the teacher as the owner of the classroom curriculum and the ultimate authority who decides whether and which computer technologies are incorporated into his or her curriculum and classroom.' (Chin, 2004, 6)

Another contrast was the length of the interventions and this also had an impact on the nature of the participatory design. The intervention described in the first case study took place over 3 months – with planning meetings being held 4 months before the start and feedback being collected a month after the end of the intervention. This extended time scale therefore allowed the opportunity to engage the children themselves with the process further on and to help us design the next trials. Therefore we conducted a number of participatory design workshops where the children as well as their teachers could reflect on, and make sense of, their inquiry learning experiences, engage in exploring the potential of participatory design, and make suggestions both about topics and about the way the activity guide worked that could feed into future design. So, design in the project has been an iterative process.

The topic of each set of trials has emerged from participatory design processes whereby teachers, students and field experts have been consulted.

In the next section of this paper we report on two case studies taken from an extensive set of trials conducted by the project. Trials conducted so far have involved heart rate and fitness, healthy eating, the effect of noise on bird feeding, urban heat islands, microclimates and sustainability (in particular, food packaging) and we report here on aspects of the urban heat island and sustainability trials.

CASE STUDY: URBAN HEAT ISLANDS

Geography is an interesting context for inquiry learning as in recent years in that subject there has been growing interest in the use of the methods of scientific inquiry. While discussing the idea of an inquiry project on urban heat islands, which had been suggested by the teachers, the idea of a field trip across the city of Milton Keynes was developed. Some preliminary data on temperature and other environmental measures was collected so that the appropriate scoping could be carried out to make the inquiry manageable. Advice was sought on the choice of appropriate sensors and investigation techniques and it was decided that temperature, carbon monoxide, wind speed and infrared irradiance were suitable measures. In conjunction with teachers, the design of the activity was developed from the starting point of investigating whether there was evidence of an urban heat island in Milton Keynes. The availability of technological support for the investigation allowed a range of measurements to be made within a single day's field trip. Using Asus Eee netbooks increased possibilities for coordination and representation of data. So the activity developed for both educational and technological reasons into a comparison of the heat characteristics of Milton Keynes (a new city) and an adjacent city. Preliminary walk-throughs had shown little variability in the readings in Milton Keynes which is a planned new city designed. Comparison with the older city 15 miles to the north (Northampton) was therefore likely to show interesting differences. There was no existing data which could be used to investigate the question, so the inquiry was in that sense authentic. Shared design of the project and the toolkit was developed through a series of meetings with the teachers in the term leading up to the students' coursework for public examinations. Table 1 shows the timeline for the extensive consultation with teachers and technology specialists in the team and other stakeholders through which the activity and first version of the toolkit was developed.

Table 1. Timeline of the participatory design of an intervention: the UHI trial

September 2007	**First meeting in school to discuss project**
October	Initial contacts and meetings with teachers Planning meeting at school Setting out basic ideas of the coursework, and possible ways PI could support Meeting at school with school IT technicians Discussing equipment - in classroom, ICT suite, field trip, and the need for a backup for equipment - what might be possible for the field trip activity, how many collection points, health and safety issues, measures to be collected classroom preparation work, ethics, whether or not to personalise interface to pupils, suggestion of a walkthrough
November	Stakeholder meeting to introduce ideas of the project and propose the specific coursework topic to be studied. Meeting at school. Discussion of: how to make the activity individual – what of the field trip is group/individual activity; whether to provide digital cameras, and how to divide roles within groups; wording for questions on the web form, storyboard interface to be developed; setting date for a walkthrough – technical and risk assessment; averages to be automated; possible measures to record, and role of sensors); discussion of having a practice with the equipment and units of measurement before field trip

	Curriculum to include Geographical Information Systems (GIS), so how to involve this; when and how can reflection occur on the field trip, if it has to be individual; tracing the route Meeting of technical team
December	Tech team meeting with Sciencescope, discuss use of GoogleMaps and GoogleEarth as visualisations Teachers lent set of the fieldwork kit over holidays (Asus laptops, GPS, sensors)
January 2008	Walkthrough with Open University (OU) team and teacher (using spreadsheet on Asus to input data) Meeting at school Teacher decision to collect data in two separate cities for comparison Suggestion by OU staff to collect min. and max. values, due to variation in readings Decision that OU staff, rather than pupils, will upload the field trip data Suggestion by OU staff that uploaded data could be stored in .csv format file, suitable for opening as spreadsheet or google map without need to re-format Digital versions of interface design discussed across OU and with teachers, mock up shown for feedback.
February	Pre interviews with teachers Meeting at school Discussion of terms to use on web form for comments boxes All groups measuring location using Global Positioning System (GPS) receivers, temperature and one other measure Discussion of routes and data collection points, based on walkthrough readings Discussion of playground practice, and the method table – to be used in submitted coursework as exam board like tabular presentation of method Classroom lessons start on coursework – begin filming lessons Coursework journals issued Playground practice session for pupils with kit to be used on fieldtrip Provision of photos and information on the measures and toolkit
March	Fieldtrip – with members of OU providing additional tech support to support use of the tools and the activity Lessons and coursework clinics – recording and technical support for: Mapping and graphing the data Analysing results and writing conclusions
April	Continue lessons on mapping, graphing and analysing results Hand in coursework Post interviews with teachers and pupils
May	Participatory design workshop to collect feedback from teachers and pupils Parent, teacher and student interviews

During the study period, each class attended 3 geography lessons per week for 8 weeks. The sequence of inquiry activities is in Figure 2:

Figure 2. The sequence of UHI inquiry activities over the 8 week study

During the fieldtrip, the students used Sciencescope data loggers and sensors to collect wind speed, temperature, infrared irradiance and carbon monoxide data, and took GPS readings of the data collection locations. These were entered into nQuire running on Asus netbooks provided to each group of 4 students, and students were encouraged to add text comments that described their data in relation to local land use. Cameras were provided to each group to take photographic evidence. Data from the netbooks was uploaded by the technical research team to a central web server that could be accessed by the students from any location (home, school IT suites, etc) through a group login and password. Photographs were saved onto USB drives. An export function in the toolkit allowed students to output data in .xls (Excel) or .kml (Google Earth) formats for representation and visualisation during the write-up period of their project.

After the first trial a further participatory design workshop was held with; researchers from both locations and invited pupils who had been involved in the trials, their teachers, and stakeholders worked together to help consider "what makes a geography project exciting?" As a consequence, when the urban heat islands project was repeated again in 2009 we were able to build upon and extend the findings from trials in 2008. The second year UHI trial involved four school classes and their four teachers and, similar to 2008, lasted nearly three months as it supported the production of students' coursework over a prolonged period. Specifically, we used our increased understanding of the possibilities for personalised inquiries within the school context to incorporate additional features into nQuire that increased student choice. Students were able to: add locations from which to gather data during the fieldtrip; choose which data they wanted to select; generate their own key questions to aid their understanding of how to address their hypothesis; mine their data for data sets applicable to each key question. An overview of the research design is in Table 2.

Table 2. Research design: urban heat islands

	Pre-Intervention	**Intervention**	**Post-Intervention**
Data collection	Test of domain knowledge, and procedural knowledge (e.g. fair testing)	Video recording of lessons and discussions with focal group students Video recording of focal group students on fieldtrips Interviews during the fieldtrip The students' coursework	Test of domain knowledge, and procedural knowledge (e.g. fair testing) Interviews with teachers and students

OUTCOMES

Our account of the development of the activity in conjunction with the teachers has illustrated how introducing technology made different measurements and analyses possible and enabled a different type of activity to take place compared to previous years. The project team's approach to personalisation was to investigate areas of inquiry that were either of direct relevance to the young learners themselves or to their immediate surroundings and communities. The inquiry topic of urban heat islands was decided on by the teachers in conjunction with the researchers, and was thought to be a topic that would be engaging to the students because of its local relevance. We investigated this issue by both interviewing the students after the project and engaging them in discussions with a stakeholder panel. The views of the pupils and teachers about the activity were essentially positive but nuanced. See for example the following discussion of this with one of the case study focus groups:

Table 3. Focus group discussion

Researcher: … you were told that you were doing a field trip and you were told that it was about urban heat island, …what did you think about that? …the fact that you didn't decide for yourselves? S1: It didn't sound very exciting, to be honest. S2: Yes, but it made you do something, so you actually got results rather than spending 3 days working out what you were going to do. S3: You could have like a class discussion of what each topic would include and then you could raise hands and have a vote. S4: But if you had like a choice and someone didn't get what they chose, then they wouldn't want to do it

The discussion at the stakeholder panel also reflected a balance between pragmatism (an acceptance that the assessment results might be better if teacher advice on topic was followed), recognition of local relevance (you would know more about your own locality) and expression of personal interest (the students said they would prefer to do something about the rainforest or the coast).

In the second case study we explored how students could be given more freedom in terms of a personal choice of inquiry and what impact that had on the participatory design approaches taken by the project.

CASE STUDY: SUSTAINABILITY SQUAD

As noted earlier, one of the aims of the project is to support inquiry across formal and informal settings. Hence, we were interested in developing inquiries for the less formal and constrained setting of one of the after school clubs. Three teachers, who had worked with us on the urban heat island trials, invited some students (aged 12-14 years) who were particularly interested in Geography to join the after school club that they named the 'Sustainability Squad'. In addition several students (of similar age) asked to join the club of their own volition. Attendance was voluntary and the number of students each week fluctuated (between 8 and 30). Engagement in club activities, particularly by the less interested students, was under their control. Therefore the extent to which students were engaged by their personally chosen inquiries was pleasing. The Sustainability Squad ran for one hour a week and focused on the sustainability of the food production cycle. The club was a mixture of a formal classroom and a more informal setting. We therefore describe the after-school club as a semi-formal context that shared characteristics with both a classroom and any informal out-of-school club context. Teachers accepted more off-task behaviour, but generally students were expected to behave well. The teachers had fewer constraints in relation to the UK National Curriculum so the design of activities was more open to influences from the young people. However they were influenced both by the concept of sustainability, a core concept in the curriculum, and by their personal commitment to the subject area in guiding the selection of activities. The club was attended by researchers who provided technical support and video recorded the activities of two focal groups of students, and took field notes. This trial gave us the opportunity to support informal personal inquiries that were not linked to the UK National Curriculum (which specifies work for teachers and students in UK classrooms).

The activities planned for the club were developed in a series of participatory design meetings involving the researchers and the three teachers who were involved. The concept of sustainability was chosen to link to work going on in the school curriculum. Students worked in small groups and selected a food product to investigate. They designed inquiries into the packaging and storage of food, which they carried out at home. Also, they carried out their own research during club time and at home, into the sustainability of a particular food that they had chosen. Following consultation with the teachers, we used large posters that represented Kellett's (2005) 'thought bubble' approach to inquiry planning and students annotated large posters of 'thought bubbles' during early club sessions, prior to putting their plans into action at home. Figure 3 shows an example of the planning carried out by one group.

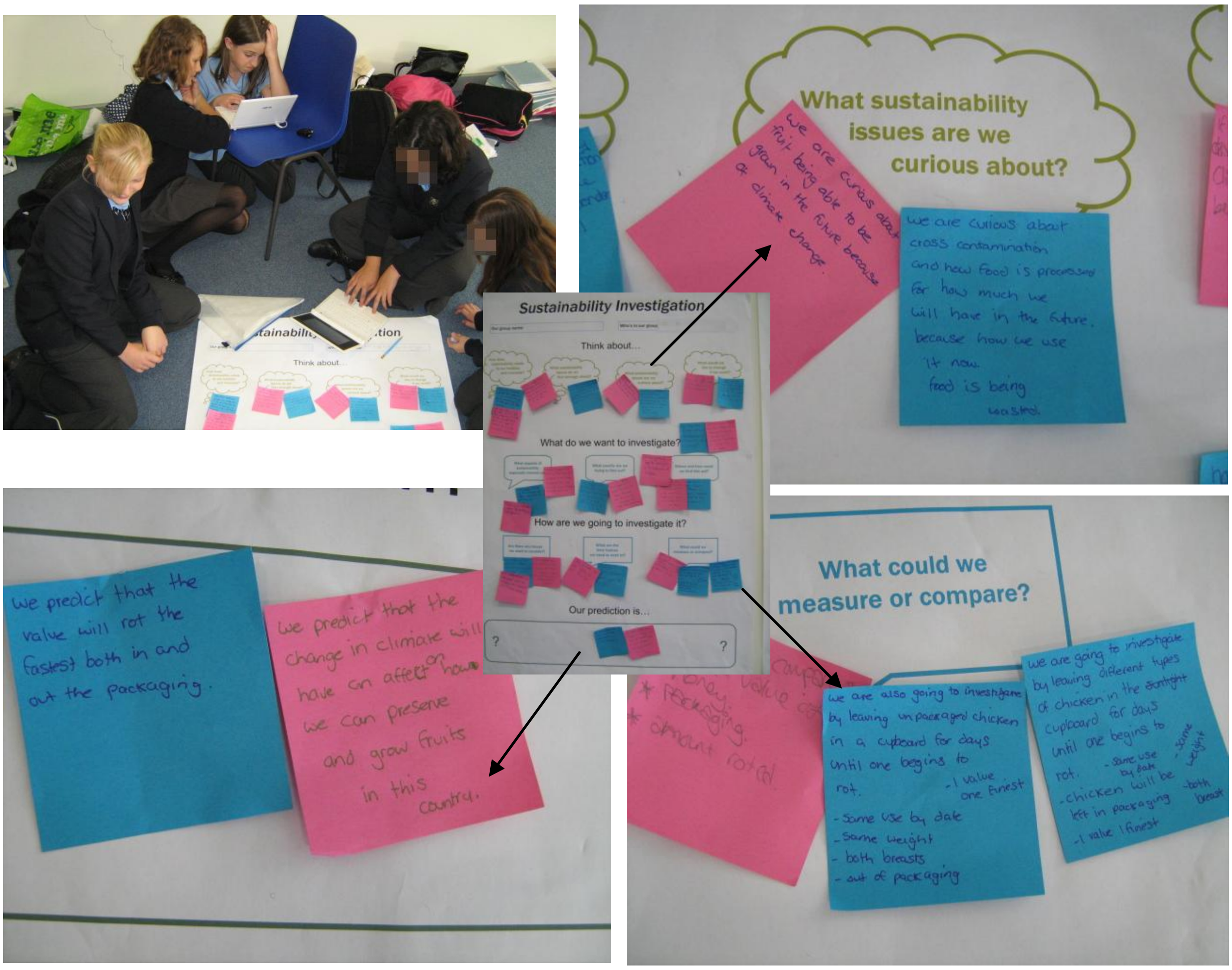


Figure 3. An example of Kellet's thought bubbles (2005) approach applied to the design of the students' inquiries (plans on pink paper were revised and presented the following week on blue paper)

An expert from our project partner Sciencescope visited the club during this stage and advised the students on the feasibility of their planned inquiries and the measures they might take and equipment they might consider using. The majority of the students modified their planned inquiries as a result of this session (different coloured paper in Figure 3 represents this process).

Table 4. Timeline of the participatory design of an intervention: the sustainability trial

July 2009	First meeting with teachers to discuss project
August	Email interchanges with teachers
September-December	Weekly sessions in the club working with pupils Thought bubble activity used to help design inquiries Sciencescope expert attends club for consultation on methods and tools Meetings and email exchanges with teachers responding flexibly to events in the club

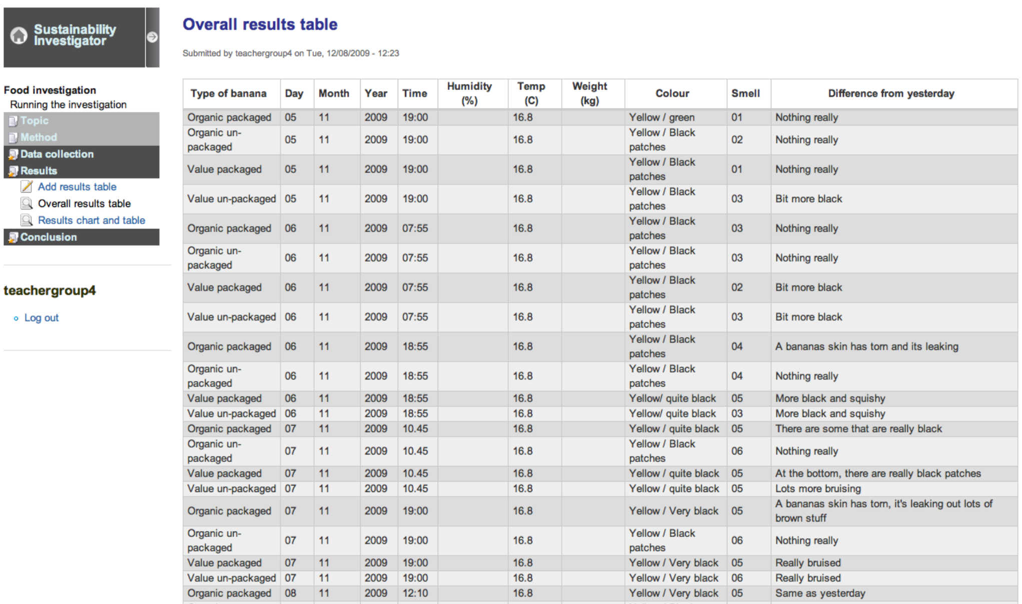
During the club, the students also carried out a 20 minute inquiry into egg packaging in which they inspected various egg boxes from 'value', 'organic', 'free range' and 'locally produced' eggs and voted on which they thought would taste the best. The teachers then cooked the eggs and the students observed their appearance (consent issues meant they could not taste them). Other activities included watching YouTube videos concerned with food production and hunting etc. The students also had the opportunity to create interview questions within the nQuire tool, to ask family and friends at home, about food sustainability issues.

Table 5. Research design: sustainability investigation

	Pre-Intervention	**Intervention**	**Post-Intervention**
Data Collection	Test of science attitudes (club attendees and a control group of non-attendees)	Video recording of focal groups of students and whole-club activities Observer notes of classroom interactions Log data of pupils' use of Activity Guide Students' thought bubble posters	Test of science attitudes (club attendees and a control group of non-attendees) Interviews with teachers and students Telephone interviews with parents

The activities in the club needed to be more fluid than was the case for normal lesson planning and as a consequence activities needed to be developed during the club in line with the direction taken by the young people's personal investigations. This was different to the PD approach taken in the urban heat islands trial discussed above, where a large part of the PD took place before the trial started. Indeed we consider that several weeks of the Sustainability Squad study involved a participatory design approach to the construction of personal investigations as seen in Figure 3. The key factor was the interests displayed by the students involved in selecting the aspects of the sustainability cycle for further study as they worked through their ideas and plans with other members of their group, with teachers and with the support of the toolkit. Therefore there is quite a complex picture in terms of the factors that influenced how work in the club progressed: technological affordances and constraints, students' priorities, and institutional priorities all mediated the way in which the toolkit was used.

Figure 4 shows the overall results table produced by one group of students who carried out an inquiry into whether organic or 'value' bananas rotted at different rates depending upon whether they were packaged or unpackaged.


Sustainability Investigator
Food investigation
Running the investigation
Topic
Method
Data collection
Results
Add results table
Overall results table
Results chart and table
Conclusion
teachergroup4
Log out

Overall results table

Submitted by teachergroup4 on Tue, 12/08/2009 - 12:23

Type of banana	Day	Month	Year	Time	Humidity (%)	Temp (C)	Weight (kg)	Colour	Smell	Difference from yesterday
Organic packaged	05	11	2009	19:00		16.8		Yellow / green	01	Nothing really
Organic un-packaged	05	11	2009	19:00		16.8		Yellow / Black patches	02	Nothing really
Value packaged	05	11	2009	19:00		16.8		Yellow / Black patches	01	Nothing really
Value un-packaged	05	11	2009	19:00		16.8		Yellow / Black patches	03	Bit more black
Organic packaged	06	11	2009	07:55		16.8		Yellow / Black patches	03	Nothing really
Organic un-packaged	06	11	2009	07:55		16.8		Yellow / Black patches	03	Nothing really
Value packaged	06	11	2009	07:55		16.8		Yellow / Black patches	02	Bit more black
Value un-packaged	06	11	2009	07:55		16.8		Yellow / Black patches	03	Bit more black
Organic packaged	06	11	2009	18:55		16.8		Yellow / Black patches	04	A bananas skin has torn and its leaking
Organic un-packaged	06	11	2009	18:55		16.8		Yellow / Black patches	04	Nothing really
Value packaged	06	11	2009	18:55		16.8		Yellow/ quite black	05	More black and squishy
Value un-packaged	06	11	2009	18:55		16.8		Yellow/ quite black	03	More black and squishy
Organic packaged	07	11	2009	10.45		16.8		Yellow / quite black	05	There are some that are really black
Organic un-packaged	07	11	2009	10.45		16.8		Yellow / Black patches	06	Nothing really
Value packaged	07	11	2009	10.45		16.8		Yellow / quite black	05	At the bottom, there are really black patches
Value un-packaged	07	11	2009	10.45		16.8		Yellow / quite black	05	Lots more bruising
Organic packaged	07	11	2009	19:00		16.8		Yellow / Very black	05	A bananas skin has torn, it's leaking out lots of brown stuff
Organic un-packaged	07	11	2009	19:00		16.8		Yellow / Black patches	06	Nothing really
Value packaged	07	11	2009	19:00		16.8		Yellow / Very black	05	Really bruised
Value un-packaged	07	11	2009	19:00		16.8		Yellow / Very black	06	Really bruised
Organic packaged	08	11	2009	12:10		16.8		Yellow / Very black	05	Same as yesterday

Figure 4. Results table for packaged/unpackaged organic/value bananas

Below is an example of the talk around the poster that led to the design of their experiment (although they swapped from chicken to bananas later on as they realised that rotting chicken may have health and safety implications for their inquiry):

Table 6. Talk in planning an investigation

Student1: So we are going to investigate different types of chicken in cupboard. Everyone do you agree with cupboard? Students: Yeah. Students 1: For how long? Student 3: Until we get results really. Until we see which one rots first. Student 1: For a couple of days Student 1(writes): Until Student 5: Until one of them rots first. Student 3: Or just observe until one starts to rot. Student 4: Will be in the packaging or not in the packaging? Student 5: In the packaging. Student 4: In the packaging. Student 3: Yeah. Student 5: Cause then we can have different sorts of packaging. The cheap chicken could be... Student 3: Should we do like four? Shall we do four? Two… value, two finest. One is packaged one not. Students 2 and 4: Yeah. Student 5: That would be two tests cause then. Yeah. Ok. Student 1: So for the first we are going to investigate by leaving packaged chicken in a cupboard for days until the one begins to rot. For the other one we are gonna say Student 2: Yeah but what type of chicken are we putting in? Student 3: Can you put another thing down? That both need to have the same date otherwise one will rot first. (student 1: writes on poster) Student 5: And it's gonna be chicken breast. Student 2: And they have to be the same amount, have the same weight. (student 1: writes) Student 3: And if they are not the same we can just cut them.

The views of teachers, students and parents were very positive about what had been achieved in the club. Students we interviewed commented on the positive aspects of choice (e.g. *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*,) and the extent to which they felt they would change their behaviour as a result of their inquiry (e.g. *we're more sustainable now. We don't buy bananas in packaging*.) Similarly parents when interviewed referred to the impact on their children e.g. *it kind of had some meaning for them, rather than just being theory and everything. And I mean he does like the practical side of anything, and it made him think about whether or not we need things in packaging, and how long things last, and all sorts*.

CONCLUSIONS

In this paper we have reported on two case studies of the Personal Inquiry project. A common theme of the project is the engagement of young people in inquiries of personal relevance supported by technology. We have illustrated how, in the first case study on urban heat islands, taking a participatory design approach to the development of activities shaped an intervention which was successful in terms of fit with subject priorities, demonstrated the feasibility of a scripted toolkit approach to supporting inquiry learning processes and received a positive response from students and teachers. However, curricular and assessment constraints limited the extent of choice and shaping of the inquiry by students themselves; which meant that we wished to explore further the impact of personalisation in a context where there was more scope for allowing considerations of free student choice and identification of issues of personal relevance. The two case studies therefore allowed for different styles of participatory design: in urban heat islands the shaping activity essentially consisted of interactions with teachers, and to a limited extent other stakeholders and worked well in the run up to the intervention. As the assessed nature of the activity introduced a number of requirements and constraints, the extent to which the overall activity could be shaped by the young people was limited. In the sustainability squad activities the process of participatory design was similar during the run up to the study but continued into the period of the running of the club and involved the young people themselves being involved in a range of shaping activities which supported the development of each group's inquiry. There are still tradeoffs however in terms of balancing the interests and different perspectives of group members and the practicality of the design of the inquiries (e.g. you can't investigate some foodstuffs rotting at certain times of the year; your investigations can depend on the access you have to equipment resources). It is worth noting too the different interpretations of personal inquiry in the two case studies and the different emphases placed on these. In the first case, students although they conducted inquiries in groups, produced individual reports. In the second case, students worked in groups and produced a joint report on the outcomes. Also the success in the inquiry toolkit in supporting these two different inquiry scenarios is worthy of note. In the first case, the students engaged in inquiries for which the toolkit had been set up in advance. In the second the toolkit needed to be sufficiently flexible to support students' inquiries that were varied and in development during the period of the club. The experience of this intervention suggests that our toolkit is sufficiently flexible for the support of investigations across varying school and home contexts.

Note: Thanks are due to the teachers and students and colleagues at the University of Nottingham who have participated in the personal inquiry project, and to Sciencescope (http://www.sciencescope.org) for participation and allowing us access to their sensors that were deployed in both case studies described in this paper.

REFERENCES

Anastopoulou, S., Sharples, M., Wright, M., Martin, H., Crooks, C., and Greenhalgh, C. (2008). Learning science in the 21st century in context with mobile technology. In J. Traxler, B. Riordan and C. Dennett (eds.) Proceedings of the MLearn2008 Conference, 7-10th October, Ironbridge, UK.

Anastopoulou, S., Sharples, M., Ainsworth, S. and 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.

Collins, T., Gaved, M., Mulholland, P., Kerawalla, L., Twiner, A., Scanlon, E., Jones, A., Littleton, K., Conole, G. and Tosunoglu, C. (2008). Supporting location-based inquiry learning across school, field and home contexts. In J. Traxler, B. Riordan and C. Dennett (eds.), Proceedings of the MLearn2008 Conference, 7-10th October, Ironbridge, UK.

Chin, G. (2004). A case study in the Participatory Design of a collaborative science-based learning environment. PhD thesis, Virginia Polytechnic Institute and State University.

DfES (2005). Harnessing Technology: Transforming learning and Children's Services. Retrieved Nov 2008 from http://www.dcsf.gov.uk/publications/e-strategy/docs/e-strategy.pdf

Good, J. and Robertson, J. (2006). CARSS: A Framework for Learner-Centred Design with Children. International Journal of Artificial Intelligence in Education 16(4), 381-413

Kellett, M. (2005). Children as active researchers: a new research paradigm for the 21st century? Published online at the ESRC National Centre for Research Methods: reference NCRM/003

Kerawalla, L., Littleton, K., Scanlon, E., Mulholland, P., Collins, T., Gaved, M., Jones, A., and Blake, C. (under review) The challenge of supporting personal inquiry with technology: microclimates

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

Scanlon, E., Anastopoulou, S., Kerawalla, L., and Mulholland, P. (under review) Scripting personal inquiry: using technology to represent and support students' understanding of personal inquiry across contexts.

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