Challenges in personalisation: supporting mobile science inquiry learning across contexts

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CHALLENGES IN PERSONALISATION: SUPPORTING MOBILE SCIENCE INQUIRY LEARNING ACROSS CONTEXTS

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The Personal Inquiry project (PI) aimed to develop and implement **personal** inquiries in secondary schools in order to motivate engagement in scientific inquiry through its focus on inquiries of personal interest to young learners. This paper describes the authors' experiences working with teachers in one school over three years, iteratively developing the nQuire toolkit[*] and pedagogical support across different inquiries which can be used in and across different contexts, ranging from the classroom to field trips and at home. As nQuire is web based, and can be accessed in different locations and on a range of networked devices it supports mobile inquiry learning and is the main resource for bridging between contexts. This paper discusses issues related to developing **personal** inquiries in schools, working across different contexts and focusing on three aspects of personalisation: choice, personal relevance and learner responsibility. It discusses the challenges faced when developing personalised inquiries in science, both in more traditional classroom contexts and in the less formal environment of an after school club. Drawing on technology supported inquiries from both these contexts it reflects on some of the constraints and tensions in providing learners with choice in their inquiries, identifying both the constraints and successes.

Keywords: Mobile; informal; inquiry learning; science inquiry; personal inquiry.

1. Introduction

Across much of Europe there is a decline in the number of young people participating in science education at school, and disengagement with science in many Western countries as children get older (Osborne & Dillon, 2008). Yet, citizens increasingly need to understand and try to address complex issues such as, global warming. Science, as Osborne and Dillon note (2008, p.15), "... provides the most important explanations we have of the material world. In addition, some understanding of the practices and processes of science is essential to engage with many of the issues confronting

[*] nQuire is freely available and can be downloaded from http://www.nquire.org.uk/

contemporary society". Inquiry based science is considered to be a productive approach to successfully teaching science (e.g. Minner, Levy, & Century, 2010). Furthermore, it is argued that a **personal** inquiry approach can motivate engagement in scientific inquiry by focusing on inquiries of personal interest to learners. The notion of personalisation itself, which has commanded much attention from government and others in Western education (e.g. Miliband, 2006) is contested, with different emphases and interpretations. In this paper we describe one approach taken by the Personal Inquiry (PI) project; we identify challenges faced when developing personalised inquiries in science, and recommendations for successful personalised inquiry within a schools context.

The PI project aimed to develop and implement personal inquiries in secondary schools. This paper describes the authors' experiences working alongside one school over three years, iteratively developing our nQuire toolkit and pedagogical support across inquiries. It became clear early on that moving from theoretical consideration to the practical application of developing successful personal inquiries would be challenging, as the school's participation was constrained by curriculum and assessment factors. For example, the first challenge was that some students did not share the teachers' and researchers' perceptions of the relevance of the first inquiry, following a topic already defined by the national curriculum, to their own lives. So in response to this challenge, in developing subsequent studies, we explored how to make the inquiries more personally relevant and how to increase choice. Thus whilst the first inquiry was curriculum based and assessed, the final inquiry took place in a semi-formal after school club where students had more control over their work and could decide on their own inquiries. Results from the different inquiries developed with this school are presented elsewhere (Kerawalla, Littleton, Scanlon, Collins et. al., 2012; Kerawalla, Littleton, Scanlon, Jones, 2011; Jones, Blake, & Petrou, 2012). This paper does not report in detail on the inquiries developed with the school, but draws on two of them in order to focus on issues for developing personalised inquiries in science and the requirements for successful personalised inquiry within a schools context.

A key aim of the project was to develop technology supported inquiries that would motivate and engage learners by being relevant to their lives and interests. We aimed to develop technology to support the inquiry process, in and across different contexts, whether a classroom, or nature reserve, as part of field work. This technological support would be available on mobile devices. The overarching project research question was: *how can effective learning be enabled with technology across transitions between formal and informal settings?* Overall findings from the seven inquiries conducted with two schools are discussed by Sharples, Scanlon et al. (submitted). Here we discuss the issues related to developing a **personal** inquiry in school related contexts by addressing the research question: *What **factors** are important to consider in designing and conducting personalised inquiries supported by technology? In particular, is there evidence of personal relevance, choice and learner responsibility?* We will illustrate our discussion with exemplars from two of the inquiries developed and conducted during the research project. Before doing that we briefly review two key literature areas: inquiry learning in

science including mobile inquiry learning and personalisation in sections 2 and 3. We will discuss the relationship between these two areas and explain our focus on personal relevance, choice and learner responsibility.

2. Inquiry Learning in Science

Scanlon, Anastopoulou, Kerawalla, and Mulholland (2011), researchers on the PI project, interpret inquiry learning as "The ability to ask questions (or hypothesize) about the natural and material world, and to plan, carry out and interpret the outcome of activities to answer those questions" (p.516). As Yeomans (2012, p.2) notes "Learning through inquiry has long been a goal of science education, with its importance articulated as early as 1910 by John Dewey", but over recent years inquiry learning in science has been the subject of much attention and debate.

A report on Science Education in Europe (Osborne & Dillon, 2008) notes the shortcomings in curriculum, pedagogy and assessment and suggests it is necessary to re-imagine science education – making it fit for our contemporary world. They argue that the current European curriculum does not meet the needs of the majority of students - who will not pursue a scientific career - but need a broad overview of scientific ideas and processes. But perhaps more importantly, as noted at the start of this paper, they argue that contemporary curricula are failing to *engage* young learners with studying science. One of the possible reasons is a lack of perceived relevance (Osborne & Dillon, 2008, p.15). However, they also note an over-use of 'transmission' teaching in the classroom by contrast with the many projects that have developed a more inquiry based approach to teaching science and some evidence that these have been effective (for example see Rocard et al. (2007)). Evidence of the effectiveness of inquiry based learning in science is also supported in a meta review of science inquiry research conducted by Minner, Levy, and Century (2010) who note: *"a clear and consistent trend indicating that instruction within the investigation cycle (i.e. generating questions, designing experiments, collecting data, drawing conclusion, and communicating findings), which has some emphasis on student active thinking or responsibility for learning, has been associated with improved student content learning, especially learning scientific concepts*".

They also note "*hands-on experiences with scientific or natural phenomena also were found to be associated with increased conceptual learning" (p.493).*

In the same way that it is argued that learning does not take place at one moment in time, (Barnes, 1992; Gee & Green, 1998) we argue that it does not happen in one location, either. For example, young learners at school engaged in a scientific inquiry on river pollution, might carry out internet searching in a lesson; and then conduct field work such as investigating pollution in a nearby river, collecting water samples that they then analyse back at school. There might perhaps also be further reading at home.

A range of research projects have investigated the using mobile devices to support inquiry based learning in science. Scanlon, Jones, and Waycott (2005) note the synergy between the affordances of mobile devices and the needs of science learners. In particular, as Stuart and Hsi (1999) noted nearly fifteen years ago, students can access various

resources wherever they are, such as software tools, data, data animations, documents, and their own work. Since then, developments in mobile devices and communications technologies and the introduction of smartphones have increased the range of possibilities. For example Chen, Kao, and Sheu (2003) and Chen, Kao, Yu, and Sheu (2004) developed a mobile system to support bird and butterfly watching and identification; Rogers and Price (2004, 2008) discuss the role of mobile devices in supporting collaborative inquiry in the Ambient Wood inquiry project and Looi and colleagues (Looi et al., 2011) report on their use of mobile technologies to support science inquiries both within and beyond the primary classroom.

Many projects support one aspect of inquiry learning process. Scanlon et al. (2011) note both the number and range of technology supported inquiry learning projects involving young people and the continuing need to represent the whole inquiry process to learners; provide support throughout the inquiry and to support the design of inquiries spanning different contexts such as the classroom, the field and home. The PI project set out to address these issues as will be discussed in section 5.

3. Personalisation

Personalisation has been high on the UK compulsory education agenda for some years now. Miliband (2006), who was the UK government school standards minister at the time, outlines five aspects of personalised learning to guide policy development which were taken up in the government's subsequent strategy for education (the Department for Education (DfE) strategy). These include: (1) Teaching and learning strategies that develop the competence and confidence of every learner by actively engaging and stretching them and (2) Curriculum entitlement and **choice** that delivers breadth of study, **personal relevance** and flexible learning pathways through the system. These two aspects emphasise the inclusion of choice and personal relevance. However, as Hartley (2007) notes, personalisation is a contested concept. Indeed even the different aspects of personalisation outlined by Miliband (2006, p.21) are quite diverse, including the idea that personal learning "*means the community, local institutions and social services supporting schools to drive forward progress in the classroom*". So personalisation is a big set of ideas that are not necessarily coherent and that embrace a number of different areas. Leadbeater (2006, p.101) suggests: "*Personalised learning assumes that learners should be actively engaged in setting their own targets, devising their own learning plans and goals, choosing from among a range of different ways to learn*."

So what do **we** mean by personal or personalised learning? Both terms are used to encompass a range of meanings, and are used in different ways by different communities and stakeholders. In this section we briefly discuss the different ways that the notion of personal learning is treated, drawing on fields relevant to the Personal Inquiry project.

In the field of mobile learning the notion of personal is often prominent. Here it can be personal in the sense of a device that belongs to an individual. For example Sharples (2000), in the context of personal lifelong learning outlines the desirable qualities of personal tools for learning. These qualities include being highly portable; adaptive to the

individual and adaptable to their developing knowledge and skills; unobtrusive; persistent, (i.e. they continue to work even when technology changes) and useful and intuitive to use by novices. This is quite a challenging list: in particular for portable tools to adapt to the individual's learning would require some kind of learner model. However, various adaptive technologies have been developed, particularly in the area of language learning, for example an adaptive system (Chen & Li, 2010) for English vocabulary learning. Compatibility across technologies is another ideal requirement that is yet to come to fruition. Even so, much of this list still stands today, and in particular Sharples's description of the lifelong **personal** learner: "*As well as calling on resources to solve immediate problems, a learner needs the means to manage this conceptual and social change: to organise the accumulation of knowledge and experience; to remember, and sometimes to forget past events and understandings; to argue and debate; and to engage in dialogues with the past, interpreting previous events in the light of new experience and creating a coherent personal history."* (Sharples, 2000, p.101)

Traxler (2007) describes mobile learning similarly: "mobile learning is essentially personal, contextual, and situated"; and notes that one of the (then) emergent categories of mobile learning is "Informal personalised situated mobile learning". Here, one of the senses of personalised is that the functionality of the device provides personal information such as location-awareness that enables the learner to access location based information or educational experiences that they would not otherwise be able to do.

Miliband's work is from a policy perspective and the focus is largely on what is learnt, i.e. the topic and why it matters: its relevance to the learner, i.e. ***personal meaning***. This notion of being meaningful to the learner is important in the PI project as will be discussed later. In the contemporary context where boundaries between formal and informal learning are blurred and permeable there is also the question of where and when learning happens. Using digital technologies opens up both these aspects. Focussing on the curriculum in general, Underwood and colleagues (Underwood et al., 2008) developed a model of the effective use of digital technologies for personalisation. In the context of supporting inquiry across different contexts, there are two important factors about this model: that it emphasizes the learner's **personal learning space** rather than the learner, and also notes the importance of space beyond the school. Thus it is acknowledged that learning takes place in different contexts and within different relationships:

"*The model clearly underscores the importance of out-of-school spaces both for the acts of teaching and learning and also for those pupils and teachers, or indeed parents, as learners.*" (Underwood et al., 2008, p.15)

In taking into account non-formal spaces, we are also considering learning that takes place beyond the school day. So we need to consider how information and resources available in one location are accessed in another; how they can be available at different

times and how the learner can be supported in remembering what they were doing and how far they have progressed with their tasks.

Finally we give an example of how the idea of 'personal' is used in inquiry learning and science, drawing on one paper by an influential group of researchers who have continued to be prominent in this area (Edelson, Gordin, & Pea, 1999). They note that motivation is a fundamental challenge and to address this motivational requirement have sought to design meaningful problems. These are **personally** relevant problems, although they do not use this term. They describe a meaningful problem as "one that has implications that matter to students" and "one that can be used to establish a motivating context for scientific inquiry" (Edelson, Gordin, & Pea, op. cit., p.400). This focus on and search for tractable *meaningful* problems is evident throughout the programme of design research into inquiry learning and report on cycles of design (op. cit.). Thus when learners interacted with data showing the greenhouse effect, the intention was to leverage the motivational aspect of the global warming controversy. From cycles of developing and evaluating inquiries they identified four properties of motivational problems within the context of investigating global warming: (1) that the topic was familiar (students were aware of the issue); (2) it had direct implications for them as they were likely to experience the effects; (3) there were social and policy implications that "draw on students' senses of fairness and entitlement" (p. 411) and (4) there is no known answer or explanation. In this sense it was an authentic scientific issue, debated by the scientific community.

Järvelä (2006) argues that using technology as a personal cognitive and social tool is also a key part of personal learning. This raises the question of how learners can keep track of and integrate the different learning activities that they carry out in different places, at different times and with different technologies. How can they integrate and keep track of these different activities? And how can they build on the learning they might do in one context with what they are doing and learning in another? One way for a system to support learners in and across different contexts is for it to be implemented on and accessed from mobile devices which students take with them across the different inquiry contexts. This was the approach taken by the PI project. Focusing on what is learnt and how, and consistent with the government strategy, and the notion of meaningful problems discussed by Edelson, Gordin, and Pea, PI identifies three aspects of personalisation: *personal relevance*; *choice* and *learner responsibility* (Scanlon, Anastopoulou, & Kerawalla, 2012). In section 6 we discuss the extent to which we were able to support these three aspects in practice.

The next section describes the overall approach of the project to designing and developing personal inquiries, the research methods and analytical approach. In section 5 we discuss the technical aspects of the PI project focusing on the development of the nQuire toolkit and how this supports personalised inquiries. Section 6 considers personalisation in practice by discussing the issues that arose during the different inquiries that were conducted focusing on the themes of personal relevance, choice and

learner responsibility noted earlier, and discussed further in section 7. Finally section 8 offers some conclusions and implications.

4. Overall Approach, Methods and Analytic Approach

An important PI project principle was *co-design of technology and pedagogy:* to design the educational activities and technology together, drawing on a participatory design approach (see Penuel, Roschelle, & Schetman, 2007) in which our interdisciplinary team of researchers (psychologists, educational technologists and computer scientists) met with teachers in our local secondary school, to plan and design inquiries. At times the team included an external science advisor, and also students. For each inquiry a number of meetings were held, and in-between and in parallel, the technological requirements were also planned and developed.

The PI project is also an example of design based research, with its emphasis on designing and evaluating and analysing interventions in an authentic context: see for example the work of Edelson, Gordin, and Pea (1999), discussed earlier. There are a number of definitions of design based research: our approach was in line with Barab and Squire's description: *"Design-based research, as conceived by Ann Brown (1992), was introduced with the expectation that researchers would systemically adjust various aspects of the designed context so that each adjustment served as a type of experimentation that allowed the researchers to test and generate theory in naturalistic contexts"* (Barab & Squire, 2004, p.3). In our project this included iterative cycles of designing (both pedagogy and technology), running an inquiry and then evaluation and analysis that fed into the next cycle. So scenarios for effective inquiry learning were developed and implemented in software where teachers could author and modify and use inquiry learning "scripts" (dynamic learning activity guides) for learners. The scripts run on mobile devices and desktop computers to support and manage the learning.

In order to address *personal* inquiry, it was decided to develop inquiries that focused on three interconnected themes that represent how an individual is linked with their local and global environment: Myself, My Environment and My Community.

The development of the first inquiry, Urban Heat Islands (UHI)[†]), is described at this point to provide a concrete example of the project approach of how the research team worked with the school. The school we worked with wished to explore how to support an inquiry that was part of required project work for the UK GCSE[‡] Geography curriculum, examined through continuous assessment in Year 11. We therefore focused on scientific inquiry within the Geography curriculum, working with the Geography teachers. This assessment requirement therefore framed and constrained the inquiry which focused on Milton Keynes, home to the researchers and the students, and chosen for two main

[†] An Urban Heat Island" (UHI) refers to the tendency for a city or town (in particular the centre) to remain warmer than its surroundings.

[‡] The General Certificate of Secondary Education (GCSE) is an academic qualification awarded in a specified subject, usually taken in a number of subjects by students aged 14–16 in secondary education in England, Wales and Northern Ireland. It is essentially the compulsory school leaving examination, and thus seen as important.

reasons. The first was the perceived *personal relevance* of the inquiry for the students: rather than focus on a text-book topic, students could develop their understanding of UHI and similar environmental investigations through planning, collecting and analysing data from *their own city and neighbourhood*. Secondly, as a designed new town, Milton Keynes does not have a dense urban centre, nor high rise buildings, but is dispersed across a grid system. Whether or not an UHI existed here was unknown: this was an authentic inquiry. The decision was made to compare Milton Keynes with a nearby older and more conventionally built town, Northampton. Students would walk through both towns on the same day, taking appropriate measures: temperature, carbon monoxide, wind speed and infrared irradiance at various locations across the towns. They used Sciencescope[§] sensors and small netbooks (Asus EeePC 701 mobile computers) on which the central software "toolkit" (see section 5) was implemented to support the inquiry. Students were also provided with GPS receivers and cameras. Lessons leading up to the day long field trip where the data was collected, prepared the students by introducing the topic, explaining what they would need to do, and giving them practice in using the equipment and the toolkit. Lessons following the fieldtrip supported their data analysis and report write up.

A similar design approach was used in each of the inquiries co-developed with this school, which spanned different time periods ranging from 5 lessons to 11 weeks for the Sustainability Inquiry described in this paper which took place in an after school club. For the curriculum based inquiry, (UHI), initial lessons introduced the topic and inquiry theme followed by an intensive data collection phase: in the form of the town walk-through following which lessons focused on data analysis and report writing. The pattern was different for the Sustainability inquiry as the students collected their own data over a number of weeks, at home. Each inquiry took account of what was learnt from the previous inquiry. For the final inquiry we wanted to increase student choice and work in a less formal setting and developed the Sustainability inquiry within an after school club.

The overall theoretical approach adopted in the project was sociocultural and a range of mainly qualitative data was collected, including data from interviews and discussions data, questionnaires, student artefacts and video data from fieldtrips and lessons. This use of a range of resources is consistent with a sociocultural approach and mindful of the integrated, complex nature of introducing intervention as part of design based research. As Sharples (2009, p.33) notes, in discussing evaluation of the PI project: *"The proposition is that the integrated system (mobile technology, inquiry methods, and learning between formal and informal settings) will provide the learning benefits, rather than any individual component. Thus, the learning benefits of each part cannot be tested separately, and the entire system is so different from traditional classroom teaching that there is little value to carrying out a comparative study of learning outcomes"*. We might add to this that it is often impossible to do such comparative studies.

[§] Sciencescope provides educational data logging and sensing products (see http://www.sciencescope.co.uk/index.html)

Thus the focus is not so much on the end product (what is learnt) but on the processes of building understanding and making connections and how the young people draw on different resources in order to make such connections. The data collected therefore can be viewed as a range of different kinds of evidence to draw on, analyse and examine. In aiming to build an understanding of what is happening in such a rich context, an appropriate approach is to consider each inquiry or part of each inquiry as a case study, for which a range of different kinds of evidence can be collected and examined (Gillham, 2000).

The exemplars given in section 5 below, to illustrate personalisation were drawn from two inquiries: Urban Heat Island (UHI) and the Sustainability Inquiry SI). We use these two inquiries as the first is an example of an inquiry conducted as part of required and assessed work with the constraints that followed whilst the second took place in the semi-formal context of an after school club. These two very different contexts have implications for personalisation. For each of these inquiries, interviews were conducted with students and their teachers following the inquiry. In the Sustainability Inquiry, parents were also interviewed as the students were working at home. For UHI, there were also focus group discussions with some students following the inquiry as part of the participatory design process (this did not happen with SI as it was the last inquiry). Artefacts such as students' written work**,** including their workbooks, data graphs and posters were made available. The classroom lessons were videotaped and all the audio data was transcribed.

In each of these inquiries, two focal case study groups were studied in detail, and video recordings were made. Thus in UHI the two case study groups were videoed at various points during their walk across the two town centres, and in lessons, whilst the sustainability case study groups were video-recorded during the after school club sessions. (See Kerawalla, Littleton, Scanlon, Collins, 2012 for more methodological details about UHI and Jones, Blake, and Petrou, 2012 for more details about SI). Data was analysed according to the focus of the particular inquiry; thus, in investigating students' engagement in improvisational interpretation of the process of field data collection, Kerawalla, Littleton, Scanlon, Jones et al. (2011) used sociocultural discourse analysis (see Mercer and Littleton, 2007) and focused on the role of talk and other tools in supporting students' emerging understanding and meaning making. As noted earlier we looked for evidence of personal relevance, choice and learner responsibility in the data available in order to address our research question: *What factors are important to consider in designing and conducting personalised inquiries supported by technology?*

5. The Personal Inquiry Project Technology: nQuire

The nQuire toolkit, a software application to guide personal inquiry learning, was designed and developed to support the inquiry process from deciding on a hypothesis or question through collecting and analysing data to its presentation, and to support inquiries that move between contexts. Because the toolkit is web based, it is accessible in different locations and on a range of networked devices including mobile devices and so it is the

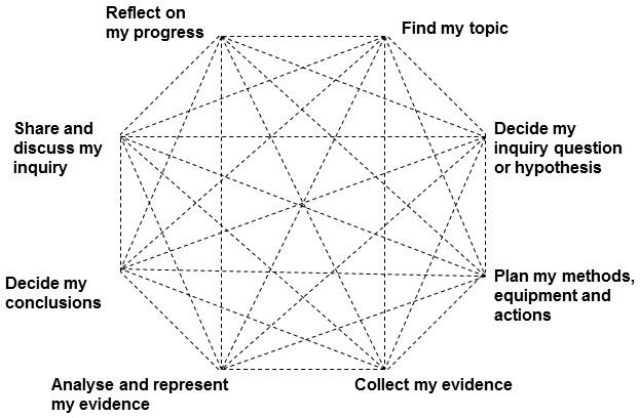

Figure 1. The Inquiry Cycle (reproduced from Scanlon, Kerawalla and Anastopoulou, 2012, p.22).

main resource for bridging between contexts. nQuire was customized to the specific requirements of each inquiry and so different instantiations of the software were used for each different inquiry (Mulholland et al., 2011).

The design of nQuire was informed by the development of a personal inquiry framework integrating phases of the inquiry learning cycle (Scanlon, Anastopoulou, & Kerawalla, 2012) which are common to all the inquiries (see Figure 1).

The system architecture enabled the phases and terminology presented to be customised for each inquiry. For example, in the Sustainability Inquiry there were five phases: topic, method, data collection, results and conclusion (see the menu on the left in Figure 2). Each phase contained a number of activities, and Figure 2, which shows an nQuire homepage screen for the Sustainability Inquiry shows the results phase expanded to reveal these different activities starting with "Add results table". Collins, Mulholland and Gaved (2012, p.92) provide further details about the constructs used to help structure the inquiries and as they explain, "(t)he activities to be undertaken are functionally grouped into phases".

Mulholland explains this process further (Mulholland et al., 2011, pp. 5-6): "The homepage provides an overview of the phases of the inquiry. The one shown (Figure 1 above) adopts the cyclic, octagonal representation of the inquiry process developed in the PI project. By selecting one of the phases the learner enters a more detailed view of the inquiry, ["activities"]. In Figure 2, a screen from the Sustainability Inquiry is shown, where pupils conducted inquiries into food decomposition. In this inquiry one group investigated cheese decomposition and Figure 2 shows the screen after they have entered their results with the overall results table displayed. The nQuire toolkit supports phase 4 of this group's inquiry, results: mapping onto the phase "Analyse and represent my

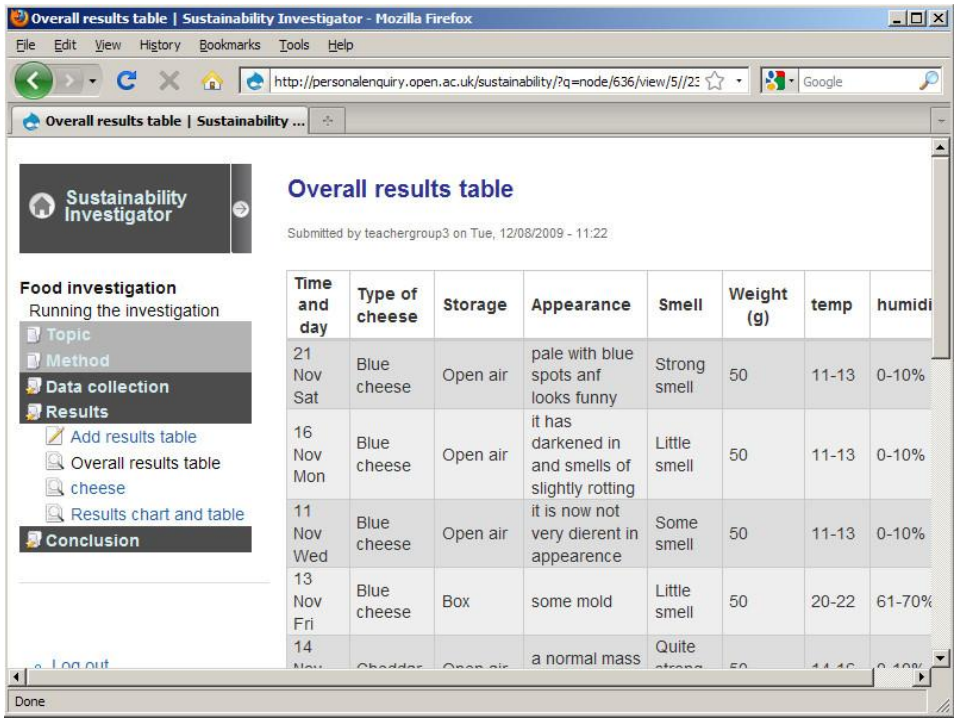

Figure 2. How the nQuire toolkit displays a group's results.

evidence" in the Inquiry Cycle (Figure 1). The parameters of the table into which they have entered their results were previously decided by the group in the methods phase (see "plan my methods equipment and actions" in the Inquiry Cycle, Figure 1). Having made these choices, the software was able to represent these as variable titles that the group could then populate with their results.

Through supporting different inquiry phases, nQuire supports learners moving across contexts and time, allowing them to access information and resources for their **own** inquiries wherever they are, and whenever they need to. It also supports location based learning where the data gathered is specific to where the learner is. For example, the data gathered might include measuring heart rates in the gymnasium (Anastopoulou, Sharples, Ainsworth, Crook, O'Malley, & Wright, 2012), pollution in the town centre, or measurements taken in the school playing fields or grounds). Finally it supports the structure of learners' inquiries, through capturing and displaying their inquiry data.

So the nQuire toolkit supports **personal** inquiries in two main ways: firstly nQuire is able to represent the individual or group's own inquiry – containing their hypothesis, data and so on. In doing this it not only acts as an aide-memoire for their inquiry by providing access to all the inquiry related data including measurements, photographs, hypotheses and reflections but also supports regulatory processes. As Mulholland et al. (2012)

explain, for the student this means understanding where they are within the inquiry, being able to review their progress to date and planning future activities. Supporting such regulatory processes is one of the key challenges of inquiry learning and one of the design aims for nQuire (see Mulholland et al. (op. cit.) for further details). Secondly, by being implemented on a mobile device, the learner can take that device with them, and have access to this information wherever they are. This is a particular feature of nQuire. Whilst related research notes the importance of being able to move across and between both different physical locations and informal and formal settings (see Cook, Pachler, and Bradley (2008) for example) other systems have not provided such support, to our knowledge. So, to summarise, the key features and advantages of nQuire for learners are that, as well as maintaining information about their inquiries, nQuire (1) reminds learners of the structure of the inquiry, and where they are in the inquiry process, (2) it supports mobility and formal and informal inquiries and (3) and it can be adapted to support a number of different types of inquiries. This enabled the students to carry out inquiries at home where they did not have teacher support.

In the next section, we consider how personalisation worked in practice, in the inquiries that were developed, focusing on the three themes identified earlier: choice, personal relevance and personal responsibility.

6. Personalising Inquiries: Personalisation in Practice

6.1. *Personalisation and choice*

In the first inquiry that was developed, UHI, which was discussed in section 3, student choice was limited because of the practical constraints in managing and support up to 76 different student inquiries (as the teachers wanted a whole year group to be involved) and also the assessment requirements:

"… we had to design ... coursework that would fit into the mark scheme of (…) and their requirements, and that would be of a suitable length, and the nature of the investigation would give them an opportunity for independence" (Teacher interview).

As noted earlier, we worked closely with the teachers – and their desire to work with a whole year group for this first inquiry illustrates their crucial role in the process. However, the assessment requirements led to some challenges. Arguably, there is a clash between contemporary forms of assessment and personalisation. Leadbeater (2006) suggests that personalisation is not compatible with current assessment systems, and both Leadbetter (op. cit.) and Järvelä (2006) argue that personalisation requires new forms of assessment that involve the learner. In this inquiry, assessment was of a more traditional form, requiring the students to produce individual project reports. The teachers wanted to include the inquiry amongst the pieces of work that the students were required to do for their GCSE assessment. Hence, the project was integrated into their course work for that year and with their assessment. However, as the teacher noted above, the assessment had particular requirements that did not fit so well with the students' group work. It also

meant that it was not possible to provide the ideal amount of choice as it would not have been practical for the teacher to support this many different student inquiry projects. Thus a compromise was sought that enabled the students to have some choice, but at the same time, conformed to curriculum and assessment requirements. So, although they developed their own hypotheses, students all conducted the same inquiry into the topic of whether or not their town (Milton Keynes) has an Urban Heat Island, thus limiting the overall inquiry choice. Another factor was that the whole year was taking part, so the teacher needed to deal with students of mixed ability, and for him this again meant constraining the choice:

"… top end pupils would probably excel if allowed to define their own coursework, but lower end pupils would risk not having work to submit. Classes are mixed ability so allowing some to set their own topic is not possible."

The teachers, like us, were concerned with personalisation and this meant the students producing their own individual and independent work, having worked in groups for the field work. The teachers therefore tried to personalise the students' classroom activities (the starting point for the students' assessed project) in two main ways. Firstly students were advised and encouraged to write about the topic in their own words in following up their lesson on UHI and their own internet research. Secondly the teachers emphasised students making choices and producing distinctly different work. They were encouraged to think independently and make their own decisions, including for example how to present their data and whether they had expressed it clearly enough. One teacher encouraged hand-made presentation of data (as opposed to using software graphics and design packages) because they saw this as a contribution to the work being "different" and "personalised".

Nevertheless, some of the compromises and tensions between different factors at play here are clear: for example individual assessment versus group work; inquiry choice versus the practicality of a single inquiry and dealing with mixed ability groups. However, as the project spanned different contexts it was also possible to develop an inquiry in a more informal context, without these constraints.

The final inquiry, therefore, 'Sustainability' was based in an after school club. This was not part of the mainstream curriculum and so was free of assessment constraints. The teachers wanted to encourage students to plan an evidence-based inquiry to be carried out *at home*, a shift from the previous inquiries. Attendance was voluntary and tended to vary each week with around 12 core members. Students were drawn from three year groups and worked in small self-chosen groups, and chose to stay within their year groups. In terms of personalisation, the most important factor about this semi-formal context was that the students could choose their own inquiries to conduct at home. There was some limit to the choice as the students were asked to select a food product to investigate for their inquiries. As they were interested in the process of food rotting, they designed inquiries into food decomposition where they investigated different features that might affect this process including the quality and nature of the food and its packaging.

Nevertheless, although students chose their group inquiries there were still constraints. The research team, teachers and visiting science expert guided them towards inquiries that could be supported by the available instruments, that could be completed at home within the available time; that were within the students' ability and that required minimal supervision. Within the theme of food decomposition, some students favoured conducting inquiries into rotting meat. Although the team discussed how we might support this, it was concluded that this posed health and safety risks and our science expert helpfully stepped in and gently directed the students away from this topic. As a consequence, we lost one group who decided to leave as they did not want to change to a different topic. However, another group was happy to inquire into rotting cheese, became excited by the idea of the cheese rotting and developed their own measure of 'smelliness'.

Students were enthusiastic about the choice they had:

"… I wanted to find out and learn new things and the fact that we could ***choose*** *what sort of sustainability project we did was really good."*

They also commented that they had had fun: *"it was fun in the aspect that we could really do what we wanted"* and this was something that the teachers had been keen on promoting. Parents also agreed that their children had been engaged in the club activities, e.g. one compared it with a previous club:

"It's the first club she's been to, where she seems to have stuck at it, and enjoyed it all the way through…..she was obviously interested in it otherwise you know, she would have stopped going." So we can see that choice was much more limited in an inquiry that was constrained by curriculum requirements.

6.2. *Personal relevance*

UHI was the first inquiry developed and it was thought that this inquiry topic would be of personal relevance to the students, as it concerned their town. It is from this inquiry that our first exemplars here are drawn, as we found that our assumptions were challenged. When we enquired about *personal relevance* as part of our post inquiry questionnaire[**], two thirds (35/51) of our respondents were not so positive when asked whether the fieldtrip: "made urban heat islands more important and relevant to you and your life?"

"… No, the fieldtrip gave us a sense of measuring a potential urban heat island but did not make it more relevant to my life."

So whilst the teachers and researchers viewed the location of the fieldtrip as relevant to the students (a concern with their own town), many students did not share this perspective. However, it became clear that for some students, whether the inquiry was perceived as having personal relevance was strongly influenced by other work in Geography and their attitudes towards it. For example, student A commented in her questionnaire:

[**] This questionnaire was developed to probe students' attitudes towards and perceptions of the use of technologies and their views about the Urban Heat Island Inquiry. Thus it was not a standardized, "validated" instrument but used alongside other data collection activities including interviews and focus groups.

A: *"I'm not fond of the social geography so maybe it made it a bit more relevant* but *basically we hear this stuff all the time and you become immune to it."*

Her friend (B below) expressed a similar view of social geography in her response:

B: *"I do not like learning about the social aspects like poverty and Urban Heat Islands."*

These two students also took part in a focus group and two comments can be made about the personal relevance of the inquiry for these girls: first, it is important to understand and take account of the existing context. These students spoke of environmental issues "fatigue", so it was not so much the relevance of the inquiry that was an issue as the fact that it was perceived as relating to environmental problems. They felt they had had a surfeit of this topic, and had been lectured at. Secondly they perceived such environmental problems to have been created by a previous generation, and one that they had little power to do anything about. These views are illustrated by another extract, this time from the focus group's post intervention discussion where A and B are also present:

A: "*Well I get very frustrated with all this kind of doom and gloom kind of geography. I much prefer to do physical geography…"*

B: "*But nowadays it's all social geography. We get you know water abuse."*

A: *"Yes the river Danube, once the most romantic river is now some strange puddle."*

….…

B*: "It's just a what have we done wrong with the world lesson."*

The stakeholder group discussion with five pupils (including these students) that followed the UHI field trip, elicited the response that UHIs were boring and they suggested visiting rain forests as their ideal field trip. For them, the interest and excitement in visiting another area was more important than "local" relevance.

The girls are not indifferent to such environmental issues, as later in the focus group B says:

"They're definitely important, we do need to do something about it, but you don't need to do it preaching to someone every single lesson."

And as noted above they also feel powerless:

A*: "You know most of the people in our class go well what can we do? And the fact is we can't do anything can we, we can't get out of school to actually do anything."*

B: *"The things like walking to school are pretty simple but most of our kids do that anyway."*

This issue was also picked up in the questionnaire where students were asked whether they might think about making changes in their lives after finding out what urban heat islands are and how they are caused. Most students did not envisage this, saying, for example that they did not think it affected them or they could not make a difference. However, despite, this "environmental issue fatigue" these two students were engaged in the inquiry and took responsibility for their learning. For example when they reflected on

their field trip in Milton Keynes and Northampton they discussed the fact that the temperature changed during the day, and suggested having two groups working in the different towns at the same time for greater reliability. So although these two girls associated the inquiry with previous lessons on environmental and climate problems, they nevertheless engaged with the activity and took it seriously, reflecting on the scientific process and how to improve it.

Also, in spite of the challenges of personal relevance the questionnaire responses indicated that, like A and B, most of the students (45/51) were engaged by the inquiry. We were surprised by these findings on personal relevance, as we had expected the students to find an inquiry into their locality personally relevant, however it is clear from this inquiry that achieving personal relevance is not straightforward but as can be seen, the lack of perception of personal relevance did not necessarily prevent engagement.

In the final inquiry, on sustainability, where students could choose their inquiry, the perception that the inquiry was of personal relevance was evident. Having completed their inquiries, students talked about to the importance of being "more sustainable", and of how they should and might behave: *"it is important to try to be sustainable and try kind of in a way not be greedy"; "Get free range eggs. Buy these bananas that aren't in packaging"*. This suggests that they did indeed view the inquiry as personally meaningful and relevant to their lives. A parent also commented in an interview about changes in his son's thinking and behaviour when shopping:

"… it made him think about whether or not we need things in packaging, and how long things last…"

In another parent interview, a student's mother described how her daughter now took bags from home instead of accepting bags offered in the shop when out shopping. She also explained how this had influenced her to changer her own behaviour: *"… And today we went shopping, in Clintons, and they asked if we wanted a bag, and I said no."*

6.3. *Personal responsibility*

There is evidence of most of the students took the inquiries seriously and also took responsibility for devising them, collecting all the data they needed, analysing the data and representing it appropriately, and depending on the inquiry, writing it up for either assessment or a report, or presenting their results in class to the other students.

For most of the students doing the UHI inquiry, the GCSE assessment was important and so this provided some extrinsic motivation. However they were keen to collect accurate data, and also interested in what the data was showing. For example, as noted in section 5.2, when A and B reflected on the UHI inquiry they discussed the fact that the temperature changed during the day, and suggested that two groups working at the same time in the two towns would give greater validity:

A: *"What we thought would be better in terms of collecting the data would be two groups: one to collect for Northampton, one for Milton Keynes. Cos then they (would be) taken at roughly the same time."*

Researcher: *"Yeah that's an idea."*

A: *"… and when you looked at the temperature difference, Milton Keynes was kind of a lot hotter because we were taking it in this warm spell. Then it dipped right down at the end because it started snowing."* So they also noted features that might affect their results.

In the final Sustainability inquiry the students were indeed working independently. Once they were at home they did not have the support of their teachers or the research team – and indeed in the after school club, the teachers took a hands off approach wherever they could. Their parents also noted that their children took responsibility for organising, planning and conducting the projects. An extract from an interview with one student's mother, below, illustrates this: *"... they were thoroughly independent, and went off and bought all their things themselves.... which you know showed great initiative. I knew they were doing it, urm…, but they organised themselves totally. ….. its nice to see that they are planning things, but also sharing their plans with me so that I can steer them if I think that they are doing something that's not appropriate"*.

Later, one student's mother commented on what her daughter had gained from the inquiry:

"I should think probably recording results is probably the most important side that she had to ensure she did properly…….. You know she will have been probably set science homework, and given conditions within which to operate, and it sound like you didn't give them nearly any conditions, urm, so, yeah I suppose she'll have learnt how to set up a fair experiment, or a fair test."

7. Discussion: What Did We Learn?

In discussing how personalisation worked in practice we have drawn on exemplars from two inquiries focusing mainly on the themes of my environment and my community.

UHI showed us that choice was difficult to align with assessment, large numbers of students and mixed ability groups within the classroom context. This is not surprising – and all part of developing design interventions in a real context and working with different partners. Clearly the partnership with teachers was crucial and this involved compromise: providing what choice was possible rather than ideal.

There were three unexpected findings in this inquiry. Firstly, some of the students were tired of hearing about environmental issues they felt powerless to address and perceived UHI as yet another of these – thus they were not enthusiastic. Secondly although it was thought that this inquiry topic would be of personal relevance to the students, as it concerned their town, some students did not perceive it in this way. However, the third finding was that these students were nevertheless engaged.

We have commented on the tensions between doing assessed work at scale within the curriculum and choice. The teachers' comments in the UHI inquiry indicated their strong awareness of the constraints of the assessment requirements on the nature of the inquiry, and they worked very hard within this, to allow as much choice as possible, and to ensure that students produced their own individual work. Whilst students did not have any choice over the overall inquiry, and data collection points and measures and tools were all already agreed on, one class chose their questions and hypothesis and all students

chose how to analyse and present their data. Yet the overall engagement is high. So it seems that although some pupils did not find the topic as personal as we had hoped many were nevertheless engaged.

Working with the teachers in the after school club allowed us to explore supporting personal inquiries in a situation where students could **choose** their own inquiries, rather than having choice over just some aspects. However, unlimited choice was not realistic and students were guided towards inquiries on food decomposition. Students had the highest control over their inquiries in this inquiry. They decided on their hypotheses or questions, what data to collect and how to collect it and represent it. As they did their data collection at home, they did not have the support of the teachers or researchers, or access to them in order to ask questions. What they did have was nQuire to support their inquiry. This allowed them to keep track of where they were (which stage of the inquiry), record and analyse their data and represent it. Those students who attended the after school club were highly engaged and excited by their work.

8. Summary and Conclusions

In this paper we have focused on three aspects of personalisation: choice, personal relevance, and learner responsibility. We have examined the extent to which these were achieved in practice in a project which developed personal inquiries in science: co-developing pedagogy and a toolkit to support personal inquiries.

Overall, our conclusion (from the project) is that technologically supported personal inquiry is indeed possible and works, even within the school curriculum. However, there are no straightforward ways of deciding how personally relevant particular inquiries will be for young people. The one inquiry that was at scale, assessed and that included mixed ability participants had limited choice, and achieved less personal relevance than we expected. Engagement was high, on the whole, and most of the students took responsibility for their learning. However, their attitude towards the inquiry was not as positive as we would have wished. The ideal position therefore is to provide as much choice as possible: choosing your own inquiry has to be the way of making it personally relevant.

There were also challenges in providing the very different semi-formal context of the after school club – but these were different challenges. Again, interestingly, it was not possible to provide complete choice for the students. Some different constraints applied such as health and safety, and the need for students to work independently, but other constraints were similar – developing an inquiry that can be conducted within the timescale and within students' abilities. The students valued being able to choose their own inquiry highly, took responsibility and attended the club voluntarily over a whole term. For both the curriculum based inquiry and the much less formal Sustainability Inquiry, we found it possible to provide customised report for personal science inquiries based on a generaliseable model of the inquiry cycle.

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