SHIFTING CONTEXTS: INVESTIGATING THE ROLE OF CONTEXT IN THE USE OF UBIQUITOUS COMPUTING FOR DESIGN-BASED LEARNING

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ABSTRACT

In design teaching ubiquitous technologies can offer new ways of situating learning within real world experiences. Yet they require new types of knowledge; both an understanding of how to work with the technology and also an understanding of how to use the technologies to respond to changing contexts such as the place and the people. We sought to understand the factors affecting how students work with the acquiring these broader knowledge bases and how this impacted on the learning outcomes in design-based learning. In this paper we discuss an approach to tertiary design teaching that involves the use of ubiquitous technologies to support fieldwork and in-situ learning and through this we evaluate the impact on teaching and learning. We will describe the methods of the study, which involved pre- and post-interviews and questionnaires completed by individual students, focus groups as well as analysis of the outcomes of the student projects. We will explore how a series of different contexts framed and affected the learning experience by exploring the context as location, technology and social setting. Since the projects required students to not only use ubiquitous technologies as tools for learning, but also as components of the design project outcomes we also highlight a series of short case studies of student project outcomes to analyse how the students integrated them into their learning environments. In the discussion of the results we will focus on how the context of the learning was understood by the students, and we will discuss an evaluation of how this changed during the course of the teaching project.

KEYWORDS

Ubiquitous, learning, situated, technology, context, site, space

1. INTRODUCTION

Ubiquitous computing extends digital media out into the physical world – whether this be the university campus, city parks and streets or through global connections to location-based data. As well as moving with the user, sensors embedded within the environment capture information about their current context, including their location, and this is used to deliver them an experience that changes according to where they are, what they are doing, and maybe even how they are feeling. In the use of such technologies interaction is shifted to mobile displays that travel with the user, bringing multiple and shifting backdrops for screen-based activities. The interaction becomes situated with everyday world activities and experiences, and the 'context' of the interaction becomes a critical facet of how the interaction develops.

Ubiquitous technologies are typically defined as wireless, mobile, networked and embedded in the physical environment (Weiser 1991), enabling everything and everyone to be connected. This research focuses on the use of a particular range of ubiquitous technologies; augmented reality, smart objects (Internet of Things) and locative media. The aim was to evaluate the value of working with 'real world' scenarios to enable new learning opportunities within the context of design based tertiary teaching (in particular Interaction design and Architecture). We explore a teaching approach that enables the student to move away from the screen into the physical world, that supports in-situ learning design activities that can have significant benefits for learners (Benford 2005, Rogers et al. 2002). Through enabling new ways of working in real-world settings these teaching activities aim to offer an embedded and innovative enquiry-based approach to the delivery of teaching in the two disciplines.

Mobile learning presents learners with a variety of contexts where they can learn and experiment in real-world situations. By mobile learning we refer to 'any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies' (O'Malley et al. 2003, 6). The premise of this approach to situated learning is that if a learner can align their learning with actual situations, scenarios, and environments, basic concepts and vocabulary are clearer and easier to remember and transfer (Gee, 2008). When learning shifts from traditional frameworks and settings then one of the key characteristics of what shapes this learning is the 'context' of the learner. According to Dey's commonly accepted definition 'context is any information that can be used to characterise the situation of an entity. An entity can be a person, a place or an object that is considered relevant to the interaction between a user and an application' (2001, 5). Arising out of this, many definitions and surveys of context have been presented such as Dix et al. (2000) and Chen and Kotz (2000). Yet defining and working with the context of the learning experience is challenging. The important aspect is that 'context is not an outer container or shell inside of which people behave inside of which people behave in certain ways. People consciously and deliberately generate contexts (activities) in part through their own objects; hence context is not just 'out there'' (Nardi 1992, 38).

In this paper we aim to establish a clearer understanding of how different contexts shape mobile learning and what lessons we can learn about how support design teaching. This is done from the perspective of the design disciplines where the 'context' is a core concept in how student projects are structured and developed. Ubiquitous technologies and tools demand the development of new trans-disciplinary paradigms, strategies and protocols for users (designers, engineers, architects and artists) and require that the sites, agents, provocateurs, disparate observers and drifters that consume and influence their output critically engage with them. As highlighted in the NMC Horizon report, that addresses future developments of technology in tertiary education, a clear agenda is outlined where students need to develop skillsets in working with 'physical' mobile and 'ubiquitous' or 'pervasive' computing projects that require the development of physical, haptic, object/device, installation/environment based systems (NMC Report, 2011). In design teaching this is a particular challenge, as traditional spatial design skills are increasingly requiring an understanding of digital interaction as integral to the design outcome. This challenges the scope of existing design teaching, and according to Stenton et al. 'the merging of virtual content with physical space extends the boundaries of classic human–computer interaction…..We need to establish a new set of design guidelines and interaction styles. This requires new skills to evolve' (102).

In this paper we discuss an approach to design teaching that involves the use of ubiquitous technologies to support situated learning and exploration and through this to evaluate the impact on design teaching and learning of a range of ubiquitous technologies. We propose that, in learning settings that deal with the design of both spaces and objects as well as digital media interactions, it is critical to challenge students to learn how to embed technologies that operate as interfaces to interactive physical, and augmented reality environments. We ran a series of interdisciplinary collaborative design-based teaching activities between undergraduate Architecture and Digital Art and Technology (DAT) students at Plymouth University and used ubiquitous computing to deliver in-situ learning for design activities. The aim was to understand the impact on teaching and learning of ubiquitous technologies[1] (Johnson & Adams, 2011) in order to evaluate the potential of new learning opportunities.

2. METHODS

We used primarily qualitative methods to document and evaluate the benefits of ubiquitous technology as both teaching tools and also materials for design projects. These included pre-, during and post- evaluation using qualitative methods including observation, focus groups, cultural probes and post project interviews and questionnaires. We monitored and evaluated how the students used specific ubiquitous technologies to develop their project.

[1] Ubiquitous technologies are typically wireless, mobile, networked and embedded in the physical environment (Weiser 1991). These include mobile and smart phones, GPS or satnav devices, sensors and RFID or 'smart objects'.

2.1 Design Workshops

We designed, ran and evaluated two three-week teaching workshops with an interdisciplinary group of undergraduate design students. The teaching workshops were run design students from two courses in; Architecture and Digital Art and Technology (DAT). By mixing the groups from different disciplines we sought to challenge them to draw on their different, but complimentary, knowledge and skillsets of how to work with the spatial aspects of the project (architecture students) an the technological aspects (DAT students). They were three weeks in duration and the outcomes were assessed and contributed to a percentage (10%-20%) of the students' final year mark.

The activities included:

1) Design and running of a series of collaborative design workshops (three week duration) which incorporated ubiquitous computing prototyping tasks enabling us to identify factors influencing the quality of students' learning (see 2.1 below for further information). Students were given a brief, a site (location) for the project and asked to work with a set of ubiquitous technologies.

2) Documentation of student learning experience using qualitative methods including: observation of how students work as 'producers', 'Think-aloud' method for students during specific tasks, student reflective 'journals' documenting progress through each workshop and visual recording of student project outcomes in-situ.

3) Post -Evaluation through interviews and focus groups of the appropriateness and benefits of technologies as teaching materials and resources –including triangulation of outcomes from documented qualitative data from all two project workshops. These were a series of thirty-minute to one hour semi-structured interviews with students at the end of the project.

2.1.1 Briefs

We situated the learning within an authentic context. This included real spatial, social and technological challenges and also set up a series of engagement activities where the students interacted and collaborated with people in the context of the project. By doing this we established the project within the framework of situated learning in that we allowed for the fact that knowledge needs to be presented in an authentic context, i.e., settings and applications that would normally involve that knowledge and 'learning requires social interaction and collaboration' (Lave and Wenger 1990). Therefore the two workshop projects had live site-specific briefs, where the students were required not just to engage with the location (the site), a set of technologies but also with people (local communities). The first of the two projects required students to explore the potential of Internet of Things (IoT) technologies and applications for the design of an outdoor leaning space at a local school in Plymouth, UK. The projects took place in October (Project 1) and November 2013 (Project 2):

Project 1: The project had a live (real) component that included the brief to design a participatory intervention in collaboration with a local school (Devonport High School for Boys, Plymouth, UK), and a group of year eleven-twelve year old pupils at the school. Students were asked to incorporate a range of ubiquitous technologies that would support learning into the design, as well as to respond the particular physical characteristics of the physical site and the learning context of the school and its students. The groups of six (three students each from Architecture and DAT courses) students ran a series of participatory workshops at the school using iPads and QR codes (with the Tales of Things[2] application) to gather student feedback and used social media to report outcomes. The culmination of the project was a large workshop showcase of the projects to the school, which was attended by approx. thirty school pupils, five teachers and representatives from local organisations such as the arts officer from the local City Council.

Project 2: The second stage of the project required the students to explore the potential of Augmented Reality applications such as Layar, Arduino and embedded sensors. Students were briefed to design a future archive for a local neighbourhood in St Blaise, Cornwall, UK. They were given a specific setting or site to work with and were required to draw on input from local people and locally available information to inform the project development. The outcomes were presented to the local community as part of a participatory exhibition in the local community centre.

[2] www.talesofthings.com

2.1.2 Participants

There were forty-eight students in total – thirty from the Architecture course and thirty from the DAT course. All students were either in their second or third year of undergraduate study. The students had not previously worked together at the start of the project and were put into groups with equal number of students from both courses. There were eight groups. The groups remained the same for the second project. All students participated in the design workshops, and completed pre- and post- questionnaires. Fifteen students participated in the post evaluation focus groups and interviews.

2.1.3 Materials

Students were required to work with a range of ubiquitous technologies; including QR codes, networked sensors, AR applications (Layar), Arduino, RFID and GPS applications. They were given access to an iPad per group for the duration of the project, as well as a small pool of iPhones, Android tablets and Arduino kit.

2.1.4 Setting

Both projects were set in actual locations; the first being the grounds of a local school (Devonport High School for Boys, Plymouth, UK). The second was a site in a small town; St Blaise in Cornwall. All students visited the sites on at least two occasions.

3. RESULTS

The key quality of using ubiquitous technologies for learning is that they allow the learning environment to move beyond the traditional teaching environment and into the real-world context. Yet we found a diverse range of ways in which students understood how the context affected the learning experience and setting. A core concept was that of what the students considered as the 'site' for the projects in the workshops. We asked students to describe how they understood concepts such as 'site' and 'ubiquitous computing', since these both played a role in contextualising the learning task. In the outcomes of the interviews with the students we found that students changed the way they understood context as a result of the project. We also observed key differences in how students from different teaching backgrounds understood theses key terms. Typically the Digital Art and Technology (DAT) students saw the 'site' initially as the technological site, such as a website or a set of location-based information, whereas the architects saw it as 'building' site or a spatial extent with a boundary. This emerged clearly in the pre and post questionnaires- see below. But in the interviews we saw more nuanced understandings of how the 'context' affected the way the students constructed and related to the learning task, and how they responded to it.

We explore the different concept of context that emerged during the running of the project and its evaluation. We consider how the students understood and learnt about the context as a location, the context as a range of technologies and the context as a social setting.

3.1 Context as a Location

In the pre and post workshop questionnaire we asked students to reflect on a series of questions. We also asked the students to document their everyday use and exposure to a range of media and ubiquitous technologies to gain an understanding of their personal context of how they might be using these technologies as part of background leaning. Below are some sample answers for how they responded to the prompt: "How would you define a site" (see Table 1). In the table the words highlighted in bold refer to the concepts, in terms of how they were understood by the students prior to the workshops and then post workshop. By comparing the change in language between the student's description pre and post workshop we can see a shift in their understanding of location or 'site':

Table 1. Pre and Post workshop responses to question - "How would you define a site"? (References to location pre and post workshop are highlighted bold to indicate the shift in the way that 'site' in understood by the students.)

Student	Pre workshop.	Post workshop.
Karlie A. (DAT)	Presuming we're not talking about websites, I would define a site as a physical area or a **location** within which an event takes place or a point of interest (for whatever reason) is.	A site is a place, location, area that has a designation for a means of development, reshaping or production. It is at it's roots a **physical space with the potential** for non-physical integration/use, but until utilised remains merely a space of potential.
Chris T. (DAT)	A site is a **specific area** that has been designated by someone for a specific purpose. For example, a building site. This would have been chosen for a number of criteria and for the sole purpose to build upon.	A site, is a specific space in which a selected user has located in order to **create**, construct, demolish or destroy an idea.
Lewis P. (DAT)	A **point or an area** on the Earth's surface or elsewhere.	A **location/place** used for artistic/technological/archaeological practice.
Shakurakh B. (Architecture)	A **specific location** which is of significance. Can be a location for something (a purpose) or a location that served a purpose in the past. Chosen area.	A **location where people's activities and feelings** are manifested.
Sam M. (Architecture)	**Defined** by a boundary, intention and a marking. A space where an area is defined, there is a mark and people are involved	**People**. Boundary. A mark – 'Land' mark.
Alex G. (Architecture)	A site is **a situation** whether that be physical or immaterial, that can be engaged with through the senses	The **area of influence** surrounding a specific point.

The student's responses indicate a broadening of the understanding of how the characteristics of the location affected interactions, and that a site had an 'affect'. The responses pre workshop tended to describe a site as having a specific purpose or of being bounded. The post workshop responses broadened out the understanding of site as one having potential, influence or a manifestation of feelings and activities. In the interview one student commented the impact of engaging with the site:

"*I like going to the site rather than looking at a computer screen you don't really get a feeling for it, You need to learn about the area, understand the area, understand the people to really get a sense of what needs are going on. So much goes on in that one space you get a sense of that space, its not just a visual thing, you have to be there to experience that, and at different times of day now that might effect it*" (Alex G.)

This also encompassed the idea that a site was not a distinct location, but also could relate to multiple or overlapping real and virtual spaces. According to one student '*for instance I would have defined space as something we inhabit physically, and populate inside a physical realm, whereas I found that space could also mean a virtual space, or a space that kind of transcends a location not necessarily one fixed location"* (Miguel F.)

This was in contrast to the pre- workshop interviews which, although divergent, tended to use terms such as 'specific', 'defined' or 'used' which suggested much less potential for the site to be transformed through interaction. In the interviews we uncovered a widening of the understanding of the scope of the project as students began to be aware of the potential of the site to be a source of inspiration. For instance one student commented:

"*It was cool to work in a set space or site. It almost felt like you had more scope. Instead of working on this, we are working on this [hand gestures of larger proportions] sort of big spaces and yeah I liked it, it seemed to make the projects bigger. I guess they were bigger projects to what we were used to*." (Paul W.).

Over the course of the project it appeared that students literally became aware of the multiple potentials of the site to inform how they learnt; the learning context literally expanded and became a 'bigger space'.

3.2 Context as Ubiquitous Computing

The range of IoT and Augmented Reality technologies were perceived by the students as expanding the scope of the learning experience. A general outcome was that the technologies created a dynamic level of interaction. For instance one student commented that: "*I learnt how digital media can be used to interact with architecture and how it brings it to life".* We also asked for students to outline how they might describe how they understood the term 'ubiquitous computing" (see Table 2). The students generally refined and developed their understanding of the term through the experience of the teaching project. But there was also a sharp distinction between DAT students (who were familiar with working with a range of technologies as part of their course, and also used them in their everyday lives more extensively and frequently) and architecture students (who typically had little exposure to these technologies and also used them in their everyday lives less extensively and frequently). In the table the words highlighted in bold refer to concepts as they were understood by the students prior to the workshops and then post workshops. By comparing the change in language between the student's description pre and post workshop we can see a shift in their understanding of ubiquitous computing:

Table 2. Pre and Post workshop responses to question - "What is your understanding of the term 'ubiquitous computing"? (References to ubiquitous computing pre and post workshop are highlighted bold to indicate the shift in the way that 'ubiquitous computing' in understood by the students.)

Student Name	Pre workshop.	Post workshop.
Phillip R. (DAT)	Ubiquitous computing means **ways of interacting** with a computer in ways other than with a standard desktop. An example might be a SatNav system.	**Technology embedded into objects**, making them part of the internet of things.
Christopher P. (DAT)	Ubiquitous computing is **combining technology** into everyday objects that give or receive data, and use this data to change the environment around them.	Using **computers/technology on/in everyday objects** to make them interact with each other or users to give us information they we may not otherwise be able to attain.
Alex G. (architecture)	Ubiquitous computing is **computing in the everyday**. This could be a bin that identifies rubbish and sorts it for you, and then connects to the internet framework keeping /collecting data on it.	**Integrated intelligence** in design.
Katrina N. (architecture)	The ability to **access computers everywhere** e.g. smartphones	Being able to **communicate with each other through technology** and using technology to change attitudes and create a fun and educating experience.
Alex M. (architecture)	**Access to internet everywhere** e.g cloud	**Computing integrated into everyday devices**, help people communicate, connect and improve productivity

The shift in understanding that emerged across the student group was from technology as 'access' or embedded within the world to that which was integrated and communicating with objects and spaces. This changed the application of ubiquitous computing, from that which passively sensed and collected data (such as a 'smart bin'), to that which facilitated interaction and was somehow seamlessly interwoven with everyday experiences. There appeared to be less of a distinction between computing as data accessed through a device to new models of communication and interaction that would similarly 'affect' everyday scenarios. In the interviews the students also described how they changed their understanding of the potentials of ubiquitous computing through a sense of occupying. One student commented that '*I learnt how technology can change a way that people interact within a space*".

Interestingly one of the issues that arose as a result of working outside of traditional teaching settings was the degree to which the learning context could not be controlled or which remained constant. Some students commented on how aspects such as the weather, and the fact that travel was involved to get to the site of the project, impacted on the learning experience. For instance a DAT student commented:

"*We spent a lot of time going to the site, during the first project. I went down there a couple of times. And the first one was horrendous, it was peeing down (sic.). Not just on that day, the weather had been going on*

for ages and I was fed up of it. We were trying to, to use the QR code stickers to stick on… brilliant, they don't work in the rain" (Paul W. DAT).

This highlights the fact that working with live contexts is seen as fundamentally different to working within traditional learning settings. In the process of situating the learning within a realistic context this introduced a lack of control of the setting; it rained, it involved travel, local people did not understand how to use a QR code etc. But the use of ubiquitous computing and real contexts meant that the student was required to confront and respond to conditions that would in fact have a significant positive effect on the learning outcomes. This potentially means that the learning value of the project has been raised, as students are challenged to work within contexts that require them to extend their skills and understanding.

3.3 Context as a Social Setting

The other important context that emerged as a result of working on a live project was that the students were working with people outside of the university learning environment. It became clear towards the end of the project how much the students valued having input from the social setting of the project site. For instance one student commented "*It was very interesting hearing how this could effect members of the public*". Whereas another described how:

"*I had to work out a way of adding digital value to a physical space, this involved mostly thinking about how people use the space, then thinking of ways that this could be changed and hopefully improved*." (Lizzie S.)

The fact that the ubiquitous computing also enabled and encouraged people to engage with the projects and 'affect' the outcomes again expanded the scope of what they had conceived as possible, and to understand the actual context of use. A student explained that:

"*They seemed like more rounded projects, they seemed like more useful projects, actually going to be used. In theory they could have been used. I think it added more of a real world component to it, instead of just us being insulated; we were working with other people*" (Paul W.)

4. DISCUSSION: MEANINGFUL LEARNING OUTCOMES

According to O'Malley et al.'s definition mobile learning is where 'the learner takes advantage of the learning opportunities offered by mobile technologies' (2003). In this study we found that the learning opportunities arose out of students exploring the potential of ubiquitous technologies as part of an authentic social and spatial context. The situated nature of learning meant that they widened their understanding of what was 'affecting' the development of their response to the brief given to them. As they engaged with the actual place, had hands-on experience of the technologies they were designing for and also interacted and collaborated with the people they were designing for the context of the design project moved from being abstract to meaningful. For example students' responses in questionnaires about the meaning of the word 'ubiquitous technology' shifted from an abstract concept of 'computing everywhere' to that of an 'integrated' or 'embedded' technology. Collela hypotheses that these types of projects 'reconnect abstractions with embodied, physical, spatial explorations that precede concrete sign systems. This may make the learners' experience of abstract concepts yet more visceral and meaningful (2000). Through this process the understanding of the dimensions of the project became broader, and also more meaningful or 'affective'. So for example the students' understanding of the concept of 'site' shifted from 'location' to a 'physical space with potential' (Karlie A.) and students reported in the interviews that the site simply 'seemed bigger' (Paul W.).

In the following section we describe a series of example outcomes from the design projects and discuss how the learning context became more meaningful due to a broader understanding of the context:

4.1 Project Outcome One: Memory Shadows

In this project titled Memory Shadows the students design proposal involved embedded ubiquitous technology in a physical setting to enable a rich context. The project proposal consisted of a QR code interface embedded in the location and linked to a series of verbal memories collected from local people

related to their experience of the place from when they were young until the present day (see Figure 1.). These invisible and private stories were brought to light and public by means of QR code technology. When scanned, using a QR reader, like a smart phone, you could hear actual audio recordings of the people that lived there. The students were able to connect the story, the people and the site and convey an understanding of the rich social, historical and cultural presence that the location represents.

Figure 1. L-R: Students' testing the use of QR codes to record and display contextual information in the setting, concept of memory shadows interface, and visualization of project in the setting.

The use of Internet of Things (IoT) technology became a way to embed historical information at the site that could be accessed through the use of an everyday mobile interface. Rogers et al. found in the Ambient Wood project 'one of the most successful forms of digital augmentation was the combination of the probing tool and the interactive visualization display' (2005), similarly in the project the students' use of ubiquitous technology to 'augment' and link digital information with hidden social information embedded in a specific physical place resulted in a richer social, spatial and technological project.

4.2 Project Outcome Two: Voting Wall

This project embeds a polling system for the community in a wall located in the centre of the small town. Through the ubiquitous technology incorporated in the wall the citizens of St Blazey would be able to vote on matter concerning the whole community. The wall consists of LED lights, controlled through an Arduino system, that could also play back a time-lapse visualisation of previous vote (see Figure 2). The voting wall connects the community and, through lighting visualisation, transforms the hidden space of decision making into an external shared space that bring the outside inside and vice versa.

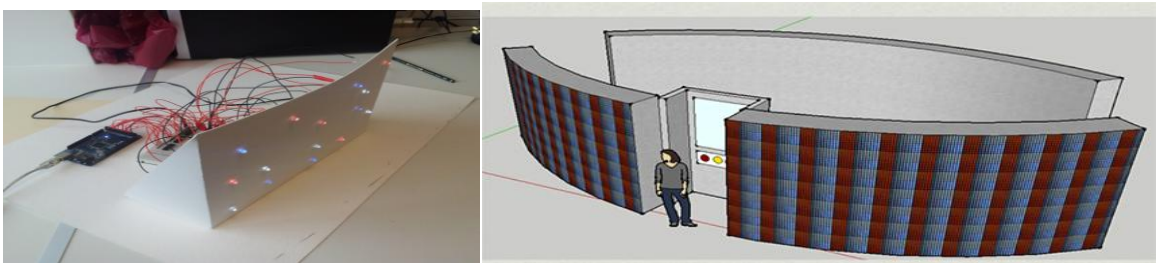

Figure 2. L-R: prototype of interactive lighting technology (Arduino Mega board and LED's), visualization of design proposal.

Rather than working with a fixed or defined set of people in mind, this project expanded to accommodate the aspirations of a small town and how their collective decisions could change both the people and the place. To highlight the comment of one student, they understood how the project "*could effect members of the public*" (Paul W.). In this project, the social context is inscribed and embedded into the physical element of the space, so that the use of the place is redefined by the socio-technological system.

4.3 Project Outcome Three: Sixth Sense

The second project extended the idea of place, from a singular physical setting (an external learning space in the grounds of a school) to a much wider understanding of the location that encompassed not only the

grounds, but the whole school and its pupils. The project proposed an environmental sensing system that was to be embedded throughout the school and which would deliver live information about energy use to an external learning space (see Figure 3.) designed to raise awareness and responsibility at towards their use of energy. By means of sensors (temperature and light) and microprocessors (Arduino) embedded into the School buildings, the system measured heat and light values and displayed this data in real-time within the external learning space in the form of an experiential visualization (see Figure 3.). The use of ubiquitous technologies such as Arduino linked into a web-based user interface enabled a key shift in the thinking of the 'site' the school had suggested for the project. The technology enabled the site to extend to the whole school, so that it became embedded in a series of classrooms, involved interaction with school students and teachers and networked with the external space.

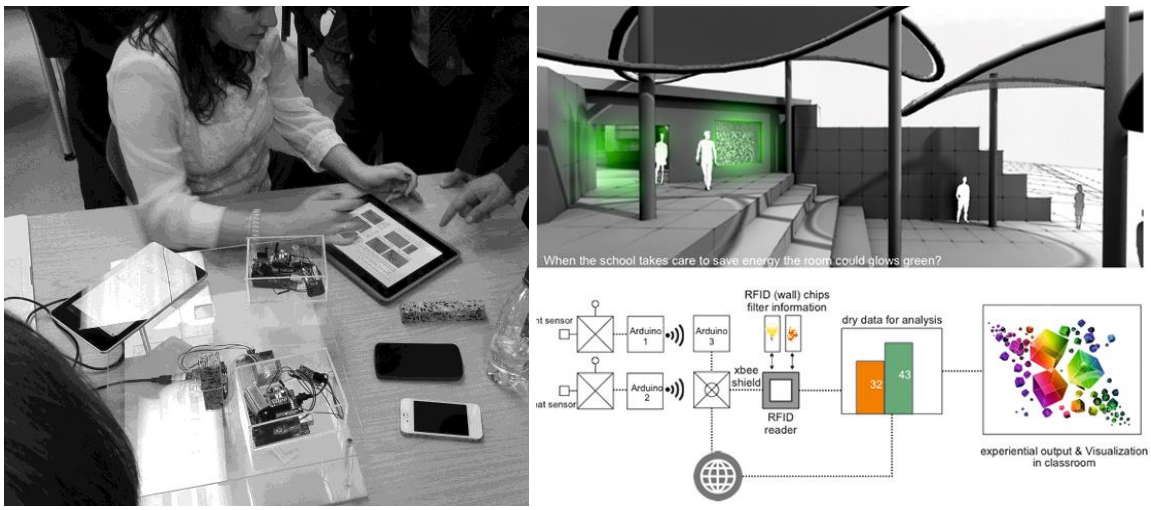

Figure 3. L-R: Sixth Sense prototype of environmental sensing interface (at school showcase event), visualization of space (above) and technical architecture (below).

The key factor that students identified was not simply the potential of visualizing change in the school environment as information, but also how creating an awareness of energy use linked to a particular place could also shape behaviour. As one student commented '*I learnt how technology can change a way that people interact within a space*", so the project facilitated a more dynamic understanding of the school as both a physical (energy using) site and a cast of human actors (staff and pupils), where the technology could become a tool to mediate this ensemble.

5. CONCLUSION

When learning shifts from traditional settings then one of the key characteristics of what shapes this learning is the 'context' of the learner. Yet defining and working with the context of the learning experience is challenging, as it inherently changeful and subjective. In this paper we discussed an approach to tertiary design teaching that involves the use of ubiquitous technologies to support fieldwork and in-situ learning and exploration and through this to evaluate the impact on teaching and learning of a range of ubiquitous technologies. We evaluated the outcomes for learners through a series of pre- and post- interviews and questionnaires as well as observation. In particular we explored how the context of the learning task was understood and explored by the students not just as a tool for design but also to design with. We found that the use of ubiquitous technologies within the context of a 'site' extended the students initial understanding of the site as a specific or defined location, to a broader and more 'affective' concept of the site. A similar broadening of the scope of the project developed out of the exploration of ubiquitous technologies and they saw these less as technologies to be accessed or used, and became more aware of the integrated nature of technology and space. Generally the benefits of using ubiquitous technologies were grounded in the fact that they took the learning space out of a contained and constrained teaching environment and exposed the learner to shifting spatial, technological and social contexts. As Nardi highlights the context was not just 'out there',

it was meaningful and had definition. We believe that this type of learning experience, delivered though an embedded and situated learning approach using ubiquitous technologies, can inform meaningful outcomes in design based teaching and assist in the development of a more contextual and innovative learning experience.

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