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Developing a child-friendly post-occupancy assessment methodology for sustainable schools

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Abstract

This paper explores the development of post-occupancy evaluation (POE) methodologies for working with children and school buildings and discusses why a tailored, child-friendly method is important for both understanding and assessing the efficient use of energy. It presents work carried out in a series of workshops with pupils in 3 case study UK schools in the East and West Midlands and South Yorkshire. Whilst POE methods generally allow examination of the physical, technical and management factors influencing the actual performance of building, they can also be adapted to examine the gap between predicted and actual energy performance of a building and human behaviour is key in such investigations. Moreover, using action research-based participatory and collaborative methods in POE provides a way to explore knowledge and attitudes towards low carbon buildings influencing behaviours. Understanding why our energy use and our relationship with natural resources have to change raises complex social issues but new school environments provide a unique opportunity for feedback methods not only to improve the performance of 'sustainable' architecture, but also to examine and influence adoption of sustainable lifestyles. This paper reports our finding from PostOPE, a research project currently being run by the Civil and Building Engineering Department at Loughborough University.

Keywords

Post occupancy assessment, comfort, children, school design, participation, action research, sustainable behaviours, sustainable lifestyles.

Introduction

PostOPE, a research project run by the Civil and Building Engineering Department at Loughborough University, is building on post-occupancy evaluations to investigate why modern buildings, designed for energy efficiency using modern simulation prediction tools, frequently fail to perform as intended. The project aims to impact on design practice and influence the energy performance of buildings and will, therefore, be of relevance to architects, engineering consultants, builders, contractors, and operators/owners of buildings. The results of this project will also be of relevance to simulation tool developers who will be able to extend the scope of their tools to allow for post-simulation decisions which impact on energy performance. In this project, a diagnostic post-occupancy evaluation and performance assessment approach is used for the case studies carried out, many of which are new schools. This approach takes the form of measurement-based monitoring of the building performance, user surveys, and the review of historical records of information from the design and construction phases of the buildings. In addition, however, the project is exploring ways to include children in POE with particular attention to the very specific problems of addressing energy consumption and the benefits of including working with children in POE.

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Assessing the difference between predicted and actual energy performance in schools using post-occupancy evaluation (POE) methods

The Children's Act 1989, a response to the UN Convention on the Rights of the Child, led to the consultation of children enshrined in law in the UK [1]. By definition, this right extends to the participation of children in the performance of new school buildings [2]. Post-occupancy assessments (POE) have grown in popularity as a means to evaluate the energy performance of new buildings, but very few approaches address the problems of working with children, the main users of school buildings, to determine the difficulties in predicting energy performance at design stage. Although researchers have developed many different ways of working with children [3] this has had little influence on POE. Experts in POE have even argued that children provide some of the least accurate data [4].

Feedback from completed buildings was introduced by the Royal Institute of British Architects (RIBA) as an important stage of the design and construction of buildings within their Plan of Work as early as the sixties, and incorporated into the RIBA's first handbook in 1965 [5]. RIBA recognised that a lack of scientific understanding of either the success or failure of construction projects had a negative impact on the profession. This led to the inclusion of the final stage of the RIBA's Plan of Work: Part M, and to RIBA arguing that feedback was the '...most cost effective way of improving service to future clients' [5]. Post-completion feedback from projects, however, has never become an integral part of the construction process. Shortly after its incorporation into the Plan of Work, RIBA removed the Part M Stage as it was reported that clients were not prepared to pay additional costs for the process. Academics took up the cause of POE [7] to develop it further, and performance assessment superseded RIBA's early efforts and attempted to provide a systematic way of evaluating the then performance of occupied buildings [6]. Nevertheless, in 2006, Stage M was finally reintroduced into the Plan of Work by the RIBA committee, as a result of changing industry perceptions and approaches to sustainability [8]. However, despite its re-emergence, it is still rare for architects to become involved in the feedback process.

Moreover, in the UK, POE studies little attention and support and are failing to become widely used by design and construction teams. The situation in the US has been relatively better (at least at policy level) where POE was incorporated in the programmes of some federal agencies with the aims of: making POE more rigorous and systematic; laying the groundwork for a database on building use and performance and establishing a clearing-house to assemble, maintain and disseminate POE information [9]. On the other hand, designers do use various computer-based analysis tools (simulation) to predict and make appropriate decisions regarding the performance of their designs at various stages of the design process. These tools go through rigorous validation procedures that include analytical testing and empirical validation [10] and in some cases calibration [11] before they are put to practical use [12]. Research studies have combined optimisation methods with performance analysis models to facilitate the search for the optimum design for specific objective functions [13]. Nevertheless, it is commonly known that discrepancies still exist between predicted/optimized and actual performance of buildings, when they are in use, often resulting in additional redesign and refurbishment costs to bring the buildings' performance in line with initial design objectives in terms of energy use and occupants' comfort. Some of the causes of performance shortfalls are attributed to the inherent limitations associated with the use of simulation tools (e.g. the lack of information on the exact characteristics of the building, especially in the early design stages, and the simplifications and assumptions built into the mathematical models on which the tools are based). These limitations have been recognized and studied over the years to minimize their effects on design solutions [14], but other causes of performance failures known to have significant effects on a building's performance are related to factors that are beyond the scope of building design performance analysis as they come into effect during the construction, operation and use of the building. These can be summarized as: the effects of users' behaviour on performance during

use; the effects of late design changes on the overall performance; the misinterpretation of design information during the construction process and inadequate workmanship; and, the inadequate commissioning, operation and maintenance of the building and systems. In practice, the difference between model prediction during the design process and actual performance in use often translates into occupants' discomfort, but rectifying such defects can also mean the redesign and upgrade of mechanical services to provide the required higher heating/cooling loads for air conditioning, resulting in additional refurbishment expenses and operational costs. Yet, without such modifications or redesign, the perceived benefits and impact of new buildings, especially those purporting to be 'sustainable' cannot be proven and in many cases, design claims are largely unwarranted.

The Building Schools for the Future (BSF) programme and the role of participation in school design

In 2004, the UK government created a unique educational opportunity with its new school building programme. Its aims were to transform learning and embed sustainability into the life experience of every child. Child participation was at the forefront of the initiative and was presented as the means to achieve some of these aims of more sustainable communities. The participation suggested was intended to encourage a sense of community, ownership and belonging, thereby influencing behaviour. However, participation does not necessarily mean inclusion, nor does it guarantee that any greater care will be taken of the immediate environment of the school or, ultimately, the global environment. Moreover, it does not necessarily mean the design of the most appropriate buildings for the school community, a design tailored to the school culture, or one addressing local needs to the same degree as more global imperatives for sustainable and just societies. Although there is a tradition of participatory research and also participatory action research with children which advocates the benefits of such approaches [15], participation as a way of increasing a sense of community well-being or creating more inclusive school communities has complex theoretical foundations, which require appropriate adaptation for a context of child actors.

The Building Schools for the Future (BSF) programme was launched in 2004 and outlined plans to rebuild or refurbish every secondary school in England over a 15-20-year period and targeted local authorities, with the most deprived schools to be addressed first. There is strong evidence to suggest that the environmental ambitions and significance of lifestyle approaches were explicit from the outset [16]. However, in July 2010, the new Education Minister Michael Gove announced that the £55 billion 20-year BSF programme was to be cancelled as part of a series of cuts by the new coalition government; only schools that had already signed contracts would go ahead to construction. At the point when the programme was cancelled, 185 schools had received BSF funding. The scrapping of the BSF programme, it was argued, would help to reduce the cuts that would have otherwise been necessary in the teaching budget [17]. But even without the school building programme providing the platform for political ambition and social change, the UK government will still require buildings to contribute to meeting the targets for carbon emission reduction and this aim will only be met if the occupants believe in the need to reduce energy consumption. Moreover, post-occupancy assessment (and including children in those assessments) acknowledges the complex relationship humans have with the built environment and can determine just how much people's values and beliefs drive energy behaviours. The aim of integrating environmental awareness and behaviours is still a highly significant issue for reducing carbon emissions, and schools provide a unique set of circumstances for exploring these relationships. Although new schools may not be essential in a difficult financial climate, a new way of thinking about the school environment and the relationship between sustainability and educational aims remains so.

Education for Sustainability

However, within the educational context, the government's aim that every school would be a "sustainable school" by 2010 has been described as over ambitious. It has been argued that whilst the framework for sustainable schools extends the school's commitment to include care for people at a distance, to future generations and to the rest of the living world, the current drive towards greater individualism, illustrated through testing and competition contradicts and erodes this ambition. An integrated approach to Education for Sustainability in the Sustainable Schools programme on the other hand, suggests that: thought needs to be directed to what and how students are taught (exploring sustainability through the curriculum); how the school campus is managed and led (through exemplar buildings and grounds); and how the school can act as catalyst for change in the wider community (through engagement with the community). These educational goals are constantly being undermined: by new buildings that are often far from exemplary in terms of their environmental performance; by parents travelling long distances by car; and by the schools themselves eroding an integrated approach by the privatisation of school catering and avoidance of locally sourced food [18].

Hence, more holistic approaches towards Education for Sustainability are required but this tends to contradict existing educational policy. The problem seems, for many educators, to be about how we understand the concept of sustainability. Huckle (2010), for example, argues that 'sustainable schools' cannot make an effective contribution to a more environmentally sustainable and just world if sustainability is only understood as an 'add-on' to the curriculum, a new subject or theme, or indeed only securing the 'greening' of the school campus. Professor William Scott, Deputy Director of the University of Bath's Institute for Sustainable Energy argues that the National Sustainable Schools Framework which introduces eight 'doorways' representing activities designed to help schools to operate in a more sustainable way. These include: food and drink; energy and water; travel and traffic; purchasing and waste; building and grounds; inclusion and participation; and local well-being and global citizenship. Whilst each can be approached individually, this separation into the distinct themes of the doorways prevents more holistic educational initiatives examining the social and cultural changes necessary to establish sustainable lifestyles. For Scott, the educational aim of developing social capital as well as reducing the use of natural resources is the essence of a sustainable school, and more connected approaches would also allow children to understand the interrelatedness of all the 'doorways'. In his critique, he posits his own more integrated definition of a sustainable school, which he describes as one which:

> 1. manages its use of natural capital to minimize its depletion; 2. has building and equipment which are fit for purpose and as efficient as possible; 3 maximizes human capital by educating people, developing capacity for social action and further learning; 4 maximizes social capital by adding to social cohesion, well-being and mutual understanding, both locally and globally; and teaches about the inter-relationship of 1 to 4 [19].

For example, the sustainable schools framework states that by 2020 the government would like all schools to be acting as models of social inclusion. Schools, according to the framework, can promote cohesion within the community and be models of social inclusion by providing an inclusive, welcoming atmosphere, one that values everyone's participation and contribution, and challenges prejudice and injustice in all its forms and from all sources. Equally, fostering local well-being is presented in terms of school pupils being empowered to make a difference in their own lives and within their communities. Furthermore, the framework puts forward the aim that children should be able to consider the global implications of actions and understand that individuals or countries cannot act in isolation when it comes to reducing carbon emissions. Each of these ambitions, however, constitutes profoundly difficult educational ideas with contested philosophical and political dimensions.

In a report prepared for the DCSF presenting evidence for the impact of sustainable schools, researchers have found evidence to show how sustainable schools have improved the well-being of children, but this is simply because sustainable schools, as the report argues, engage and include young people, promote healthy lifestyles and make connections with the wider community, thereby enhancing social cohesion [20]. What is missing from the sustainable schools programme is nevertheless an integrated consideration of the relationship between sustainable design (and sustainable architecture), sustainable behaviours and educational achievements. For Scott, the educational aim of developing social capital as well as reducing the use of natural resources is the essence of a sustainable school, and more connected approaches would also allow children to understand the interrelatedness of all the 'doorways' [19].

Professor Gert Biesta (2009) Director of Research at the Stirling Institute of Education at the University of Stirling and editor of Studies in Educational Philosophy has equally identified problems with the sustainable schools initiative and presents an even wider criticism, arguing that there is a lack of educational purpose in government policy to create new schools. He has suggested that there is not only a lack of clear thinking concerning the creation of sustainable schools, but also a context which has seen both a rise in the use of spatial language and a shift in emphasis in educational thinking from the activities of the teacher to the activities of the student, brought together in the creation of 'environments for learning' or 'learning spaces'. This development in language is mainly, he argues, the result of a shift in emphasis in educational thinking from the activities of the teacher to the activities of the student, and the change in the role of the teacher to that of a facilitator of the learning processes, and although a lot can be said in support of this shift, there are also consequences of this lack of attention being paid to the purpose of education. Biesta writes: 'It is, after all, one thing to create environments that support learning, but it is another thing to create environments that support a particular kind of learning' [21]. One of the problems of the sustainable schools initiative from the educationalist perspective is one of curriculum, but the design of schools suffers from the same lack of attention to purpose.

Designing and building sustainable and low-carbon schools in the UK and the value of POE methods

The construction and operation of the built environment today, including the associated manufacturing and transport of materials, accounts for over 50% of all energy consumption in Europe and around the world. Energy use in school buildings accounts for 37% of this and equates to a total of 3.5 million tonnes of carbon dioxide equivalent each year. Today, schools account for around 2% of UK greenhouse gas emissions, roughly the same as all the energy and transport emissions of Birmingham and Manchester combined. This is also equivalent to 15% of the country's public sector emissions (statistics from the final report of the Zero Carbon Taskforce) [22].

The Sustainable Development Commission's carbon footprint for the schools estate estimates that, for England, the sector emits 9.4 tonnes of carbon dioxide equivalent each year. If we are to reduce this to achieve more efficient school communities, designers, more than ever, need to be able to understand how their newly-built school designs perform to be able to address the current and future needs of school communities. More importantly policy imperatives to reduce carbon emissions will continue to drive the requirement for accurate and holistic means of evaluating building energy performance.

According to Baird (1996), post-occupancy evaluation is intended to answer some basic questions: 'How is a building working?' and 'Is this intended?'. POE differs from more technical post-construction technical evaluations or performance checks in that it has addressed issues such as occupant comfort, worker satisfaction and productivity [23]. In theory, post-occupancy studies are meant to cover all aspects of building performance (space, cost,

aesthetics, operations, use, occupant satisfaction, management, environmental performance and so on). For completeness, they should also take due account of the context in which a building was procured, briefed, designed and occupied, and context often turns out to have a much more important influence on performance than initially envisaged [24].

Cooper (2001) has argued that without feedback processes being in place, new systems or design approaches effectively remain prototypes. To understand fully if a building is truly effective, feedback needs to be sought by those using it [25]. This is especially significant for 'sustainable' architecture, but in the UK, as already stated, such assessments receive little attention and are failing to become widely used by design and construction teams.

The most significant of the UK post-occupancy evaluation efforts, to date, is the Post-occupancy Review of Buildings and their Engineering (PROBE) series on the performance of a number of buildings, published in the CIBSE journal during the 1990s. Although the Probe study did not deal with the early stages of the building design, or energy and environmental predictions, it established that, for energy performance indicators do not seem to be acting as efficient engines for improvement. It concluded that 'It is perfectly normal for UK buildings to use much more energy than their designers predicted'[26].

Research by Andreu and Oreszczyn (2004) on building performance in comparison with design targets, which unlike Probe encompassed the whole building process, from early key design decisions to occupation, observed an increase of more than 15% in the energy consumption of two from the three buildings they studied in comparison with their intended energy consumption in design stage. This difference was even more noticeable in heating energy demands, which, in one case, increased the usage of gas energy by more than 23% compared with predicted figures [27].

In addition, POE has, as already stated, had a strong following amongst academics interested in behavioural science and architectural design. POE has been concerned principally with evaluating and assessing the performance of buildings based on user experiences, although this, it can be argued, has now evolved to consider a more holistic, process-oriented evaluation [28]. The Royal Institute of British Architects sees POE as a systematic way of gathering invaluable information on the performance of their designs, which would allow them to build guidelines to achieve continuous improvement [29]. From the perspective of facilities management, POE represents a diagnostic tool for operating problems in buildings once occupied [30].

There is, however, additional potential for new school building programmes, where POE not only offers information about design performance: a real and actual determination of the performance of 'sustainable' architecture, but also a more complex social science data about the values, beliefs, attitudes and behaviours of users and the influence of these on energy consumption.

Identifying user behaviours influencing energy consumption

Whilst architects strive to produce sustainable and low-carbon schools it is evident, as already suggested, that the reality of energy performance in new school buildings is often somewhat different from the design intentions. Identifying factors contributing to this increase in energy is vital in the drive to reduce carbon emissions.

New buildings, including new schools, are consuming substantially higher levels of energy than anticipated. Furthermore, building technology into new schools often achieves the opposite of what is intended. The pressure on educational policy to increase the levels of ICT in classrooms also means that electricity usage can grow in new school buildings without people caring or even noticing. Presence detection, for example, in corridors can force lighting to come on during the day and teachers can override controls to use whiteboards in classrooms or to prevent lights from switching off. In response to some of these frequent observations surrounding the design of low-carbon schools, Rod Bunn has argued for 'humane design' of sustainable schools. This is an approach which he defines as ergonomic and democratic and a

design solution that truly meets users' needs, and not the designers' beliefs or ideas regarding what the teachers ought to have (whether or not they really want or need it). Bunn writes: 'Hand-held remotes have been given to school-appointed eco-warriors to control lights. Pupil power can be as powerful as BEMS [Building Environmental Management Systems] when it comes to truly intelligent lighting control' [31]. As per Bunn's argument, however, these more passive or human-centred approaches have not entered the mainstream in school design in the recent drive to build new sustainable schools.

Zero Carbon Schools Taskforce

The recent UK Zero Carbon Schools Taskforce, set up in order to identify how to create low-carbon and energy-efficient schools, identified the important role schools have to play in the move to more sustainable lifestyles [32] but also identified many problems with the energy performance of new schools and many issues even with the aim of building 'zero carbon schools'. The Zero Carbon Schools Task Force was established early in 2008 by the Secretary of State for Children, Schools and Families, with a remit to advise on what needed to be done in order to reach the goal of all new school buildings being carbon neutral by 2016. The work of the Zero Carbon Schools Task Force came to an end in December 2009. For the Zero Carbon Task Force, the five steps towards making this happen, described as the Carbon Hierarchy, are: engagement with school communities; reducing demand (assisted by engagement leading to changes in behaviour); driving out waste by better design (which will need more knowledge and skills in the design and construction industries); decarburizing school energy supplies and neutralizing any residual emissions [33]. The report argues that low and zero carbon buildings will only be achieved if action is taken across a range of fronts, including technical, financial and social areas. Although the Task Force was reporting during a period of intensive new building, in a climate governed by cuts in public funding, behaviour-driven factors have become even more significant in reducing carbon emissions. Indeed, the report even states that retrofit will have a far greater impact than a single focus on new build [34]. Further recommendations include that Partnership for Schools (the delivery body for the BSF programme) develops a post-occupancy evaluation (POE) process for all schools within BSF and a methodology for an in-depth energy study which is applied annually to a sample of schools [Recommendation 25] [35]. Other recommendations also include: the gathering and publication of performance data in order to monitor progress [Recommendation 26]; a targeted programme of energy-reducing refurbishment work (linked to behavioural change) in order to cut emissions in existing schools [Recommendation 27]; and education and engagement initiatives for staff, students and communities [Recommendations 3, 4, 5]. All of these recommendations promote the need for a continuous educational cycle of feedback, monitoring and action to achieve a reduction in carbon emissions.

Choosing the right POE method for a "sustainable" school: assessing the performance or measuring the impact of sustainable design?

As the Zero Carbon Task Force has suggested sustainable design requires integrative design solution – action on all fronts. However, the conflict between technological solutions and changes in lifestyle is becoming an increasingly tense and problematic issue. Moreover, 'rebound' effects are now widespread in new housing: people are being provided with energy-efficient, well-insulated homes and, as a result, demand higher levels of comfort, thus using more energy than in the old houses [36]. Although there is an increasing acknowledgement of the need to provide integrated approaches to addressing both technical performance and occupant behaviour, there is little offered by research on how to motivate more sustainable behaviours and, as Fionn Stephenson writes: 'Without knowledge of both technical performance and occupant behaviour, it will not be possible to optimize [sic] design or to predict actual performance with [any] reliability' [37]. In other words, the reality of knowing

how to provide effective integrated approaches is, it seems, far in the future. Both Vale and Vale (2010) and Leaman, Stevenson and Bordass (2010), in a recent collection of papers on post-occupancy evaluation of low-energy housing, consider what ethical positions need to be adopted by occupants, policymakers and practitioners alike, in order to address the issue of substantially reducing consumption. Whilst Vale and Vale suggest facilitating change in occupants' lifestyles rather than just changing buildings [38]: for Leaman, Stevenson and Bordass, the future lies in a 'New Professionalism' where practitioners engage in an ethical imperative for improving housing performance by using evidence-based qualitative and quantitative feedback as a routine part of their services and responsibilities [39].

During the last three decades, many researchers have developed methods and techniques adapted to their own POE study objectives. Since these studies have different concerns and deal with different sets of information and expect different outcomes, a number of different methods have been developed. A review of the literature available in 2003 showed that, at the time, there were more than 150 POE analysis methods available [40]. This makes selecting a technique for a specific study very difficult. On the other hand, trying to develop a personalized approach academically is risky because of the possibility of simply re-inventing an existing method. Furthermore, the chosen method might result in too much unrelated data being gathered or not enough data to allow conclusions to be drawn. A further difficulty is choosing a POE method that produces interpretable findings and which is inclusive of all occupants – including children. According to Leaman (2003), of the 150 POE techniques that are available worldwide, the effectiveness of any technique will be dependent upon: results which are easily comparable with previous studies; the time and patience of respondents not being abused; value in terms of quality and content; relevance in a given situation; reliability in terms of giving similar results when used by different people within similar circumstances; and addressing of factors related to the needs, activities and goals of the building users [41]. A guide to POE developed by the Higher Education Funding Council for England (HEFCE) also offers a summary of established methods, and the associated techniques used for each. These established methods can be adapted and amended where necessary and include building walk-throughs, facilitated group discussions, focus groups, questionnaires, energy use surveys, and other energy data collection (including from bills) [42]. Motivations for including POE assessment within a design process can a useful perspective on the inclusion of children's perspectives in evaluations. Whyte and Gann (2001), for example, suggest a number of drivers determining the use of any particular method: applying design skills with greater effectiveness, improving the commissioning process, improving and adhering to user requirements, improving management procedures, offering valuable knowledge for guides and regulatory design processes, can help target refurbishment [43]. For these researchers, POE's primary benefit it would seem is in its ability to bring together valuable information which supports continuous improvement of architectural design. As already stated, it will only be known if a building, including a "sustainable" building, offers the maximum benefit intended throughout its lifecycle, if an evaluation and feedback process takes place on its performance. The information gained from POE carries significant value for those involved in a design project, with particular parts of the information derived from POE, being of benefit to the different stakeholders for different reasons [44]. Nevertheless, performance based approach to building design, makes a series of problematic assumptions about the nature and future of sustainable architecture. Moreover, performance based approaches can under estimate the influence of a school culture in the management of a schools energy consumption.

Guy and Farmer (2001) have argued that making sense of sustainable architecture is a confusing business with a bewildering array of building types, using a variety of different technologies, diverse approaches and justified by a highly diverse set of interpretations all purporting to be 'green'[45]. Where evaluating sustainable buildings is assumed to be a study of different technical solutions, Guy and Farmer argue that this represents the primacy of a

technological approach which dominates the environmental research programme within architecture schools and a lack of research into the essentially social and behavioural questions implicated in the practice of sustainable architecture. The debate on sustainable architecture – including on sustainable schools – tends to side-step this problem [46]. For Guy and Farmer this is founded on the notion that rational science will provide an understanding of the environment necessary to adapt. In addition, Guy and Farmer argue that further implicit in this model is a process of standardization which also means that context tends to be ignored [47]. As an alternative they suggest abandoning the search for the true and incontestable definition of sustainable buildings and instead treating the concept as a question, one that demands raising awareness of all the issues that can be considered [48]. But policy to ensure the design of a more "sustainable" built environment, has increased pressure for buildings to "perform well", and reinforced this approach. Policy in this respect contributes to the problem.

Guy and Farmer challenge the notion that the built environment is merely a physical entity and resist its categorization only in scientific terms. They argue that individuals and groups, and the strengths of their beliefs and their competing views, shape the built environment: discourses that take material form in the shape of buildings.

POE, however, as a 'scientific' method does not operate at the level of standardization (although information derived from assessments can contribute to these types of analysis) but rather works to understand how well buildings suit user needs and is by nature contextual. Users and their competing discourses can be central to POE analyses.

POE's other motives and the role of school culture in managing change

The Egan report (1998) highlighted the lack of "process for auditing client satisfaction" and acted as a driver for POE [49]. Moreover, Jaunzens and colleagues (2002) offer further motives for the use of POE which include: staff time/efficiency gains through the provision of appropriate facilities; reduction in staff discomfort; increased staff motivation; an ability to spot potential system inefficiencies. POE in the school context has also been motivated by the need to improve educational performance but even these motives can miss the opportunities POE programmes can provide.

Sanoff (1992) argues that culture appears to have the strongest influence on attitudes to change and school managers and heads in failing schools are becoming increasingly aware of the power of school culture to block change. This has led to the encouragement of greater involvement and participation in the turn-around of failing schools. Sanoff writes: 'Ignoring the importance of a schools culture is usually associated with a lack of understanding of the dynamics of organizational culture and an assumption that culture is unimportant' [50].

To change a culture in school, however, requires an understanding of how it is formed, and how it influences thinking and behaviour. Sanoff argues that it requires a climate of open discussion about the underlying assumptions of the purposes of education: cultural strategies rely upon open discussion and shared decisions [51]. Improving a school means assuming responsibility to guide the process by listening to, synthesizing and sharing information, rather than providing direction and control.

The theory underpinning such an approach is the idea that schools are communities rather than institutions and in communities people construct their own social lives rather than have those lives created by others (he cites Thomas Sergiovanni, 1994) [52]. Sanoff cites metaphors such as Sergiovanni's 'learning community' which is predicated on the belief that change can and should occur from the centre and be culturally based.

Sanoff's work emphasizes the importance of participatory methods in researching the built environment. Participatory Action Research (PAR) takes lived experience as the starting-point for investigation and places emphasis on the research process in terms of the culture and values revealed and knowledge co-produced. The goal of PAR is not only to describe reality but to change it, starting with the understanding that 'people – especially those who have experienced

historical oppression – hold deep knowledge about their lives and experiences, and should help shape the questions [and] frame the interpretations' of research [53]. Significantly, PAR projects have also been commissioned by the UK Department of Environment, Food and Rural Affairs (Defra) to explore how to encourage sustainable behaviours [54].

Caitlin Cahill (2006), however, has questioned the theoretical and methodological issues of working in a participatory way with young people [55] and of the possibility of research as a vehicle for social change [56]. Cahill situates young urban women's perceptions of their own lives at the centre of her research project. Her approach is the antithesis of the dominant paradigm of academic research being an exclusive conversation of 'us' with 'us' about 'them' and follows that of Paulo Frieire to raise the consciousness of those involved. As Cahill states, however, there are numerous social forces acting at the same time to maintain the norms of behaviour and of power relationships, many of which can be unacknowledged in the research process by even those most attentive to inequalities.

Developing a participatory post-occupancy assessment method for sustainable schools and why we chose to develop our own "children friendly" approach attentive to school culture

According to Bordass (2009), new schools in the UK are uniquely problematic for the following reasons: the building fabric performance is not always as good in practice as it is in theory; the building systems and controls are too complicated; the demand-responsiveness to patterns of use is poor, and such unmanageable complications lead to avoidable waste. Contradictory policy factors, often driven by educational objectives, are also causing an increasingly intensive use of energy [57]. These design factors include: non-traditional spatial planning; interactive whiteboards which undermine daylight strategies; drives for more ICT with the aim of having one computer per student, thereby increasing electricity consumption; extended hours for community use, and adding features in a 'tick box' approach, making the building too complicated. Schools are beginning to look more like offices, and making schools look like offices means that they use energy like offices. Furthermore, Bordass states that dysfunctional procurement methods are making it difficult to pay any attention to the detail of a building's performance, and thereby to provide more integrated solutions which consider technological solutions and human behaviours. Bordass, like Bunn, does not, however, present a technological option for improving building performance or one that suggests better control of the building environment through more intelligent design. Instead, he argues that engaging people in the problem could halve the demand.

More forceful commentators on educational policy from the building assessment field argue like Bunn that a focus on technological features in sustainable schools will not provide the answer to the question of how to build sustainable schools. He proposes that process and simple solutions are more important [58]. As already stated, however, the argument for engaging people (let alone children) in sustainable behaviours is far from simple [59]. Within the field of post-occupancy assessment of buildings (in which academics such as Bunn, Bordass and Stevenson work), papers are being presented which explore the contribution made by lifestyle factors and social norms as well as issues of culture to the energy performance of buildings [60].

School culture reflects the difference between the actual goals of a school as opposed to the status goal and in this sense it is a significant factor in determining why there is a mismatch between predicted and actual energy. School cultures are not all the same. Factors that shape a school's culture include its history, its community and the expectations of pupils and teachers. A school culture incorporates ideas about a school's history, leadership style, ideas of what should or should not happen and traditions involving educational standards [61]. Understanding attitudes and behaviours regarding energy consumption amongst pupils, staff and the leadership teams of schools was an important part of our research and it was necessary to choose a

research method that could allow insights to emerge about the school culture. Choosing and working with broadly action-based research approaches and theories of co-research allowed us to do this and at the same time to attempt to challenge some attitudes and behaviours.

Sanoff argues that participatory methods of research, including action research methods, have their roots in community 'grass-roots' development in the 1950s and 1960s and in advocating that the poor and oppressed should be mobilized to promote social and economic progress. Participatory methods of research have also influenced community action and building programmes where residents have taken control of their communities and of decision-making for improvement. Community action programmes combine top-down and bottom-up approaches. Community building projects grow from a vision of how communities function normally, where community members create, in collaboration, community institutions that help to achieve their aspirations as well as strengthen community fabric. Communities create and develop the vision of what they want to become and how to achieve this. Building social capital is the primary objective but building social capital also means building human capital, strengthening the capacities of individuals and families. In this respect the focus of any method should be to build on existing community strengths. An important part of participatory research methods is also the need to maximize learning and methods should also encourage dialogue and debate; nevertheless, participation processes also have stages which include awareness raising, understanding, decision-making, and implementation.

In choosing a participation method of research we need to ask the same questions as when choosing a post-occupancy method for determining objectives. For example, is the participation intended to generate ideas, to identify attitudes or to measure opinion? For Sanoff, the value of participation methods is that they examine and can address local issues, they can be designed to be inclusive and adopt many different strategies for inclusion and can be tools for satisfying the needs of groups often unheard and ignored. Youth participation has benefits which include social and relationship skill building. Sanoff writes: 'Investment in the human and social capital of young people through their participation in community problem solving is the best way to build skills and connections' [62]. In addition, he argues that youth should not be included in community building projects as a matter of courtesy, or to keep them out of trouble, but because they belong to the community process [63]: if organizations, including schools, advise against participation because problems are too technical or complex, they too can encourage dependency and passivity. Participatory approaches in architecture have hence developed as tools for advocating justice and an ecological vision and as an antidote to more conventional top-down, style-obsessed, 'architect-expert' approaches to practice. 'Proactive [participatory] practice begins well before there is a paying client and continues long after the contract ends' [64].

For Sanoff, POE is a participatory research method as it involves users in their own assessment of their everyday physical environments. It can also act as an information gathering stage of a community participation process, before goals are defined for improvement and a plan of action designed. Participatory action research, however, represents a different paradigm within the research methods already discussed. The long-term goal of PAR is to empower people to effect social change. PAR attempts to break down the barrier between subject and object, between researcher and researched: research is seen as a process of creating knowledge, at the same time as an education and mobilization of action for change. PAR methods adopted for POE thus suggest the mobilization of strategies to change environments, architectures, energy behaviours and lifestyles. PAR reflects the view that participants who use the environment, and who are the traditional subjects of research, should be active participants in both the research (including the development of the approach and data collection) and in changing the environment. The researcher acts as facilitator as it is the community that decides on the problem, methods of addressing and analysing it, and strategy for solving it. PAR

methods offer a means to forge real and effective dialogues with the people who use an environment.

Our Research Method

POE can be defined in terms of method in four categories: direct observation (recording real-life behaviours); interview; simulation (eliciting responses to visual representations); and written questionnaires [69]. One of the best methods for POE, according to Fionn Stevenson, is open questioning [65]. Stevenson argues that open ended interviewing brings out hidden factors and tacit knowledge not revealed by structured questionnaires. It avoids wasting time and energy as the interview adapts itself to each situation and is more revealing where the same participant is interviewed more than once. For Stevenson, open questioning reveals problems that would not have been revealed by a standard questionnaire. This corresponds to much of our own argument and choice of a method informed by PAR. But, as already stated, Stevenson's preference raises some difficulties when working with children. Children's study researchers have, for example, challenged the use of "focus groups" as inappropriate [66]. Those working with children in this area tend to use more art-based methods as a way of researching with them [67]. Watson and Thomson describe a participatory "walk-through" POE method, which they opt for in the context of school buildings to engage participants, writing:

> By avoiding a pre-set agenda, the time available is spent discussing and recording only those issues most relevant to the participants and no time is wasted on anything else. The walk-through process makes the exercise more engaging, the building itself prompts users' reactions and allows participants to clearly describe and demonstrate the issue they wish to raise in whatever detail is necessary [68].

PAR however suggests a deeper engagement than any of the more common methods of diagnostic evaluation. Environments have meaning for people and some meanings are shared. Buildings convey messages which reflect the society and culture of occupants. PAR allows an exploration of the vocabulary and perceived meaning of inhabited spaces, a reflection on personal and shared narratives, and the creation of options for change.

Reviewing POE methods, PAR and research with children allowed us to develop a framework for a POE approach for sustainable schools, which could also provide us with data about energy behaviours and environmental awareness in the school communities we visited. Using this approach allowed us also to consider educational theory promoting the importance of sustainable citizenship and Biesta and Cahill's approaches to developing subjectivities [70].The purpose of the research with children and young people was to study their everyday experiences and interpretations of and within their new school buildings. The diversity and range of young people's experiences is rarely taken seriously and little is known about children's everyday experience of the built environment of schools – especially more energy efficient and sustainable schools. The emphasis of the research was a contextualised understanding of young people's experience [55]. In order to provide this understanding a deliberately open approach situating young people's perceptions of their own lives at the centre of the research was taken.

Hence, based on a review of existing methods for POE research, and from those suggesting researching with children or co-research (and other broadly action research based methods) we devised an adapted POE method for schools. POE methods are fundamentally "multi-modal" and approaches may include a single or a number of different ways to collect data, such as: pre-visit questionnaires; gathering technical data to establish construction, systems, etc.; semi-structured interviews with key stakeholders (client, designer, contractor, occupant, manager); field observations during walk-through visits; predicted and actual resource cost information; physical monitoring where necessary, including thermal imaging. As already stated, one of

these methods is free open questioning bringing out hidden factors and tacit knowledge not revealed by structured questionnaires, important we felt for our own research [65]. However, whilst this raises some difficulties when working with children: as stated, children's studies researchers have, for example, challenged the use of "focus groups" as inappropriate [66]. And those working with children tend to use more art-based methods [67]. Watson and Thomson's participatory "walk-through" method we felt could be appropriately adapted (with the addition of a video camera) to allow for open discussion and creatively engage children [68]. The use of open discussions, walk-throughs and art based methods adopted, formed the basis of our emergent participatory post-occupancy assessment methodology. The walk-through interview provided a spatial agenda and a performance opportunity to respond to – a chance to make a documentary with the video. This strongly contextualised the research results.

Open discussion was also opportunity for storytelling and for critical engagement with some of the design problems in building sustainable schools. A final design task was added to give children a chance to reflect on the research exercise and "to do being an architect". Conversations during activities, whether walk-throughs or during the drawing/design task were recorded, and selected dialogues transcribed. Analysis took the form of a fairly simple content analysis but the use of broadly action based research methods meant that the transformative aspect of the research project also played an important role in motivating engagement.

Hence, our methods acted to facilitate a deeply context based discussion, the capture of these conversations which formed the basis of our analysis, and final drawings which produced by children, supported the findings. We discovered that children's story-telling was also often used as a way of explaining others energy behaviours or to convince others' about a new knowledge or a new concept. Narratives attempted to describe complex issues and often persuade others. Thus we also attached particular importance to stories told by the children about their new school environment and energy behaviours and saw this as a first crucial step in providing ways to productively engage with the issues and concerns of sustainability.

Results

In terms of the new school environment it was interesting to note that in all the case study schools children expressed some criticism of common design problems and their solutions, despite significant attention being paid to these by the designers and some innovative solutions. (see Table 1). Children knew that lights were left switched on at night time when the school was unoccupied and corridors and stairs were also observed to have artificial lights unnecessarily switched on during daylight hours. Both were seen as wasteful by the children. Many of the windows in the schools were being locked shut (for safety reasons) making opening them for natural ventilation difficult for teachers and prohibited for students. The PFI arrangement was also observed to have a significant impact on the culture of the schools depending, to a greater or lesser extent, on the nature of the school leadership and relationship with the management company. In a discussion about the prohibition over drawings being stuck to the walls, which was described by pupils as a rule of the building management company, one Year 9 (13 year old) said: '*It's like living in a council house where you can't do anything to it*". Other stories that emerged from children focused on a convoluted system in place to maintain the building, the "office to telephone" was perceived as a great distance away – Liverpool, Manchester, Cornwall and Scotland: '*The changing rooms smell a lot because the drains get blocked and if something happens it means you have to ring up Liverpool to put it on the caretakers list that the drains need fixing because that's where Headquarters are'* (Year 11 participant, Case Study 2). Even the control of the temperature of the building in one instance was understood as dependent on the weather in Manchester, the reason why it was particularly unresponsive to the actual temperature outside. Rules and regulations about the school environment were thus determined not only by teachers but by the higher authority of the building owners and "care" was eroded to an enforced responsibility for the others property.

Table 1

Design Issue	Case Study 1(two schools one mainstream, one Special School on the same site)	Case Study 2 – Mainstream secondary school	Case Study 3 – Mainstream Secondary School
Circulation, stairs and lifts	"...everyone pushes you out of the way [...] and it takes you about 10 minutes to get out and you have to try to hold onto the handrails to pull yourself forward [...] I go down with my brother and he makes a little circle and I walk. [...] Older people think they are cocky and they can do everything and so they go down the wrong side of the stairs" (Year 7 pupil)	"This is a very big area, the rooms are very big, and there is alot of room for people to just wander up and down the corridors. Huge rooms, lots of big open spaces down here. This is the area you are not allowed at lunchtime. You are not allowed up the stairs in the corridor at all. People have thrown things, the lights have been broken, there are lots of dents in the ceiling".	"The first day I got lost, then it was quite easy because every room is marked out, every level too, there's three different colours." (Year 7 pupil, first session)
Food queues, break time and lunchtime space	(Dialogue from 'walk-through') "As you can see for that many of us there are not many seats. This is theirs [the Special Schools'] that's where they have dinner and they don't come any further than that. For how many seats there are, how many people in the school, there are not many. These are the door we are not allowed to open [doors to the Special School] This is where we stop."	"There is the dining hall. It's not big enough for the whole school and umm it means that there's not enough room for everyone to sit in and so packed lunches have to go downstairs into the atrium".	"…sometimes people run past and knock you with food and it just goes over the floor. Because that's what happened to my friend" (Different voice but in the same session) "…but like yesterday, I had sandwiches yesterday, when the seller said to us we needed to go out the hall they needed to fill the tables. We didn't have enough time to eat out lunch and then the bell goes."
Gym, fitness suites, dance rooms, changing rooms and showers	(Dialogue from 'walk-through') "As you can see we have these lockers but no one uses them, you can see they are broke" Researcher 1: Do you have to carry all your PE clothes around all day?" yeah, in a bag". (different 'walk-through' session)	(From a 'walk-through') "The drains in this department are very dodgy and the changing rooms smell a lot because the drains get blocked and if something happens it means you have to ring up Liverpool to put it on the caretakers list that the drains need fixing because that's where [building company] Headquarters are."	"...we should have lockers, we have to carry our PE kit around all day. I think we should have lockers where the PE room is so that when we have PE... or in our form room." (From a final 'design' session)
Windows and ventilation systems	"We also have this automatic window thing for when it gets too stuffy. When you produce too much CO2 the windows open, it's automatic [...] If you talk too much in classroom they open (laughs)".	"In the whole school there are automatic windows that you have to open and close with a key and there are only about four keys in the whole school. So that kind of means that you can't open the windows in some departments because you haven't got a key."	"Sometimes they [the classrooms] are really warm and the windows don't open. None of the windows open. Only the lower ones. In the summer it's really hot" (Year 7 pupil.) Researcher 1: "Are there things you think the architect could have done better?" "Just the windows."
Outside space, sports facilities and multi use games areas	"That's the field and the tennis courts and there were the Astroturf is that's where we had our old building you can't come down here at break but you can at dinner." Researcher 2: "So does it have a fence or something for where you cannot go in the break time?" "No a teacher just stands there".	"Up at the top we have a MUGA. Multi-use games area. There are some people on it right now. And then we have the bus station. There is a stage thing that, an outdoor thing, for a band, but we've never used it".	"At the moment we're in a different playground to all the other years. [...] I think it is better I think it's because older kids are just bigger and if we're on the same playground they can hurt us easier." (Year 7 pupil.)

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Design Issue	Case Study 1(two schools one mainstream, one Special School on the same site)	Case Study 2 – Mainstream secondary school	Case Study 3 – Mainstream Secondary School
Social space (strongly related to the lunchtime experience)	"We go up to the shop at dinner time but at break we just stay around. I'll just stand around over there or walk around. We have got a coffee machine now that we are allowed to use and a lot of people stand around there [...] At dinner we play football on the Astroturf and a lot of different years join in". "...we go out to chippy. It's nicer. There are just year 10s and 11s and there's no queues [...] We go most days (different voice). Not every time to eat just to get out of the madness" (Year 10 pupils).	"This is the atrium space [...] It does get a bit messy because there are not enough chairs and people have to wander around and hope for the best and see if they can find a seat at lunchtime [...] It is used as the packed lunch area at lunchtime and chairs come out of the cupboard over there for people to sit on but there isn't a lot of space and there isn't enough room for everybody to 'sit-in'".	"We like to sit under the stairs where there is carpet and a radiator, but we're not allowed. We just like to sit there because it is inside. We just like having a quieter area you can sit and just be with your friends [...] They should have little benches [outside] people can sit on and a shelter in the winter. I know it is cold but I do like to go outside to get some fresh air. And also the lads when they play football would have somewhere for their bags" (Year 10 pupil).
Quality of space/ innovative design	"It [Global Conference Room] is for meetings as well but while we are learning there are cameras. There is meant to be a camera here. Where you can learn with other schools and you can learn the same lessons. But we've never done it". (Year 10 pupils on "walk-through")	"It's a good job the camera doesn't pick up smell because it stinks. [The school had a ongoing problem with smells from the drains.] Sometimes it smells, the drains arn't very good."	Researcher 1: "Are there things you like the most about the building? Things your primary school didn't have, or just things you like?" "It's better because you get to move around the school and not just stay in one classroom." (Year 7 pupil.)
Natural and artificial light	"It happens [automatic lights switch on] when you go in, but when you go out everyone turns them off anyway. In PE that's what happens as they will go off in the changing rooms and in PE you just have to jump about a bit. In the store rooms it is straight on. You walk in and it just turns on. Cleaners' cupboards and stuff".	"In the art and music corridor there are full size windows, they go down the full length of the building, the problem is that you have to, if you have projectors on in an art department you can't actually see because they don't have blinds so you can't actually lower the blinds so the projector can see so then you can't really see anything."	"I think we should stop lighting the school in the day as the sun lights it up alot and we're wasting electricity" (Final 'design' session, Year 8 pupil). "Are the lights movement sensitive? I don't think in the corridors they are. They could be movement sensitive, but even just a switch" (final 'design' session, different group of pupils)
ICT and computers	"All the computers are always on, they are never switched off by the power. They are always on standby. [...] it's just that the monitor is off. You just logoff and you don't shut it down".	"In there [computer room] as well is the study centre [full of computers] and it gets very hot and even if the air con is on only slight areas get it and it gets very hot."	"On hot days the IT suites are the best because of the air conditioning."
Windows and ventilation systems	"We also have this automatic window thing for when it gets too stuffy. When you produce too much CO2 the windows open, it's automatic [...] If you talk too much in classroom they open (laughs)".	"In the whole school there are automatic windows that you have to open and close with a key and there are only about four keys in the whole school. So that kind of means that you can't open the windows because you haven't got a key."	"Sometimes they [the classrooms] are really warm and the windows don't open. None of the windows open. Only the lower ones. In the summer it's really hot" (Year 7 pupil.)
Attitudes to energy efficiency and sustainability	"I think we should but we have gotten used to everything and don't want to go back to basics" (different session) "They are telling us to be energy efficient but... They stand there in science and say you need to save energy and then I say well turn your lights off"	""I don't even think we are trying. It feels like they don't even think they care. But they are always banging on about it. They are always telling us to save energy but why not them".	"...if no one moves in the classroom then the lights go out and so it's like when people go out of the room the lights go off and so the bills are lower. So do you think the bills are lower in this new school? You're paying less for your electricity and gas or not? Possibly not, because it's bigger."

Nevertheless, the school rules and regulations were a constant source of stories, but there was a tendency in the case study schools visited for schools to impose what was seen by the children as irrational rules and regulations and which were in fact adopted to restrict charges imposed for additional cleaning or repair, by closing the toilets, for example. Restricting the playground and other spaces during lunch and break times, was seen as "stupid" by children. Nevertheless, children's own initiatives were also often frustrated by others: *'...there are these recycling bins that after a year and a half we finally got in the school but there isn't really enough of them round the school for people to know that they are there and use them'* (Year 11 participant, Case Study 2).

With the new wave of school building and with an ongoing need to retrofit old buildings, children will grow up within architectural environments which pay significant attention to the idea of reducing energy consumption. Whilst many of the more hidden energy efficient design strategies architects use often go unnoticed in schools by children and adults alike, children are, nevertheless, quick to point out many of the more obviously wasteful energy behaviours happening in otherwise energy efficient schools: '*They are telling us to be energy efficient but... They stand there in science and say you need to save energy and then I say well turn your lights off... they are always banging on about it. They are always telling us to save energy but why not them* (Year 9 participant, Case Study 1). Asking children why adults are like this, is often met with idea of habit or 'set ways'. When asked if we should care more about the energy the school uses and be less wasteful, one participant states: '*I think we should but we have gotten used to everything and don't want to go back to basics'* (Year 7 pupil, Case Study 3). However, just by the nature of their new environments, different ideas towards energy efficiency will emerge and it is important that schools act to reinforce emerging lifestyles, and be more critical of adults 'old ways'. Whilst an increased motivation to care for a building and its environment could be seen as a positive contribution to a sustainable school and an element of a more sustainable lifestyle, it is important to note that where this is driven by rules and by penalties imposed on school budgets; and perceived as prohibiting the proper use of the building by children; it prevents children establishing their own authentic relationship to the environment and thereby a deep or lasting critical perspective on the problems of sustainable development.

Involving children in POE provides architects with: highly contextualised information about how a school is used; information about how to improve the quality of children's experience in school, both social and educational; information about how the school community is contributing to the energy performance of the school; and detailed and highly context dependent information about the factors contributing to the difference between predicted and actual energy performance. Adapted POE methods can also provide opportunities (and for some schools and some children these many be the only opportunities) to explore and reformulate the values and norms impacting on energy behaviours. The future potential this offers is significant. As the Zero Carbon Taskforce for Schools have recognised, it is only with a combined effort of design and behaviour that low carbon schools can be achieved.

Conclusion

Our nascent approach to post-occupancy assessment research is being developed to provide an integrated understanding of energy use in buildings. The dialogue of children and other users of the building provide essential clues to the factors contributing to the difference between the actual and predicted performance of new buildings. However, the methods we are developing also offer the potential for much more than this, they are opportunities: to explore children's relationship with their environment and to transform this relationship; and to provide

the foundation for an integrated approach to building a sustainable school. Feedback methods are by their very nature ways to continuously learn about the performance of buildings and to understand people's behaviours within to those buildings; adapted feedback methods also provide ways to begin to change those behaviours.

People rarely change their behaviours through rational calls to do so but neither does increased knowledge simply and straightforwardly lead to actions which are more or less environmentally friendly or appropriate. Researchers tend to separate the issue of encouraging pro-environmental behaviour lifestyles and technical innovation. And whilst more and more buildings are achieving higher energy efficiency ratings, efficiency improvements are expected to be offset by lifestyles factors, including: population growth; growth in the numbers of households and decreasing levels of occupancy. Based on trends for consumption it is likely that in Europe that the level of resource use will increase. In fact, the International Energy Outlook report 2009 predicted that global energy consumption is set to increase 44% between 2006 and 2030 with non-OECD countries seeing a 73% increase. According to current accounting procedures emission for the UK are seen to be decreasing, but these 'in country' procedures remove from the calculation emissions from trade and travel which are increasing. Emissions linked to consumption are increasing. Being able to approach and to understand complex social issues determining energy behaviours is essential to developing more sustainable communities. Policy makers have argued for devolving powers to communities to meet forthcoming environmental challenges [71]. However, different communities will have different resources to tackle climate change and different problems to solve. Models of change can overlook a whole range of cultural practices, interactions, habits, impulses and human feelings that contribute to, or limit behaviours. Moreover, devolving power to communities can refuse difficult intercultural and intergenerational issues. Working with the 'culture' of communities is key to more sustainable lifestyles. Building a sense of agency in relation to the natural, social and built environments and establishing shared values and social norms are neglected approaches. The human dimensions of adapting to climate change including reducing energy demand tend to take second place over technical solutions. If we are to adapt to climate change we will all have to look at the part the environment has to play in supporting our comfort and well-being and enter into a discussion of community, relation, social cohesion and all the political and philosophical complexities this entails. Moreover, people will have to reconcile the need for reduced consumption with consumerist norms and aspirations. This presents a profound challenge for both architects and educationalists.

This paper argued that integrative approaches to the design of the built environment, whether new build, retrofit or maintenance, is essential if we are to genuinely approach the problem of building low carbon schools. Effective education for sustainability has to be participatory, inclusive and grounded in non-prescriptive, culturally sensitive and context dependent understandings of sustainability. Innovative POE methods are one way to include children and school communities in shaping their environments and results reported in Table 1 demonstrate the understanding children have of their environment. This research is part of an ongoing project and further case study workshops are planned. We will be returning to case study schools to explore and monitor potential changes in use and in attitudes and behaviours as improvements take effect.

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References

[1] United Nations Children's Fund (UNICEF). *A Better Life for Every Child: A Summary of the UN Convention on the Rights of the Child* [Online]. Available at: http://www.unicef.org.uk/publications/pdf/crcsummary.pdf [accessed: 14 November 2010]; The UK Government (1989) *The Children's Act.* Available online at: www.legislation.gov.uk [accessed: 9 January 2011]

[2] Baroness Morgan, 2008 *Official Report of the House of Lords*, 11 November, Vol. 705, c 573

[3] Christensen P, James A. 2000 *Research with children: Perspectives and practices*. London: Falmer Press; Fraser S, Lewis V, Ding S, Kellett M, Robinson C. 2004 *Doing research with children and young people.* London: Sage; Kellett M. 2005 *Children as active researchers: A new research paradigm for the 21st century?* London: ESRC National Centre for Research Methods; Lewis A, Lindsay G. 2000 *Researching children's perspectives.* Buckingham, UK: Open University Press; Barratt-Hacking, E. 2009 "Listening to Children: developing the sustainable school", *Transforming Our Schools* [Lecture series]. The University of Nottingham.

[4] Adrian Leaman, personal communication, 2007.

[5] RIBA, 1965, *Handbook of Architectural Practice and Management*, RIBA Publications, London.

[6] Preiser, W. F. E., Vischer, J. C., 2005, *Assessing Building Performance*. Elsevier.

[7] Cooper, I., 2001, "Post-occupancy evaluation – where are you?", *Building Research and Information*, Vol. 29, No. 2, special issue: Post-occupancy evaluation, pp. 158-163.

[8] Bordass, B., Leaman, A., 2005, "Making feedback and post-occupancy evaluation routine: A portfolio of feedback techniques", *Building Research and Information*, Vol. 33,No 4, pp.347-352.

[9] Federal Facilities Council, 2001, *Learning from our buildings: A state-of-the-practice summary of post-occupancy evaluation*. National Academies Press, US.

[10] Lomas, K., et al., 1997, "Empirical validation of building energy simulation programs", *Energy and Buildings*, Vol 26, No 3, pp. 253-275; Strachan, P., et al., 2008, "History and development of validation with the ESP-r simulation program", *Building and Environment*, Vol. 43, No 4, pp. 601-609.

[11] Strachan, P., et al., 2008, "History and development of validation with the ESP-r simulation program", *Building and Environment*, Vol 43, No 4, pp. 601-609.

[12] Malkawi, A., Augenbroe, G., 2003, *Advanced building simulation*. Taylor & Francis. US

[13] Bouchlaghem, N., 2000, Optimising the design of building envelopes for thermal performance. *Automation in Construction*, Vol 10, No 1, pp. 101-112; Malekzadeh, M., 2009. Positioning of outdoor space in house design: an energy efficiency and thermal comfort perspective. PhD Thesis, Loughborough University.

[14] De Wit, S., Augenbroe, G., 2001. "Uncertainty Analysis of Building Design Evaluations", Proceedings of the 7th International IBPSA Conference on Building Simulation, August 13-15, Brazil.

[15] Fielding, R., 2006, "Best Practice in Action: Six Essential Elements that Define Educational Facility Design", *CEFPI Planner*, December; Fielding, M., Bragg, S., 2003, *Students as Researchers: Making a Difference.* Cambridge, Pearson Publishing; Kellett, M., 2004, "Just teach us the skills please, we'll do the rest: Empowering ten year olds as active researchers", *Children & Society*, Vol 18, pp. 329-343; Frost, R., 2009, The HCD Student Partnership: Learning from Young Leaders of Research. In Fielder, J. & Posch, C. (eds.), *Yes they can! Children Researching their Lives*. Germany, Verlag; Wheeler, A., 2010, "Children's participation in educational projects and sustainable design – Comparing the UK and Nicaraguan contexts: An interview with Harry Shier", *International Journal of Children's Rights,* 17th January, 2009, pp.457-474; CABE, 2004, *Being Involved in School Design*, CABE, London.

[16] Blair, T., 2004, *Speech by Prime Minister Tony Blair on the 10th anniversary of the Prince of Wales' Business and Environment Programme* 14th September 2004 Available: http://webarchive.nationalarchives.gov.uk/20061023193551/number10.gov.uk/page5087 [accessed 14 November 2010]

[17] Vaughan, R., 2010, Osborne blueprint sees schools sigh with relief. *Times Educational Supplement* (*TES)*, 22 October. Available: http://www.tes.co.uk/article.aspx?storycode=6061306 [accessed: 14 November 2010]

[18] Huckle, J., 2010, Sustainable schools: Teaching beyond sustainable consumption [Online]. *School Design Futures: Seminar 2*, 27th - 28th April 2010, UKERC The Meeting Place. Available at: http://www.ukerc.ac.uk/support/tiki-index.php?page=1004_MP_SchoolDesignFutures [accessed: 14 November 2010].

[19] Scott, W. 2009. Critiquing the Idea of a Sustainable School as a Model and Catalyst for Change. *Transforming Our Schools* [Lecture series]. The University of Nottingham.

[20] DCSF (2010) *Evidence of the Impact of Sustainable Schools*, DCSF Online Publications

[21] Biesta, G. 2009. Creating spaces for learning or making room for education? *Transforming Our Schools* [Lecture series]. The University of Nottingham.

[22] Department for Children Schools and Families (DCSF), 2009, *The Road to Zero Carbon. The Final Report of the Zero Carbon Schools Taskforce* [Online]. Available at: http://publications.education.gov.uk/[accessed: 14 November 2010].

[23] Baird, G. 1996. Building Evaluation Techniques. McGraw-Hill Professional Publishing, US.

[24] Gaia Research, 2003, *Sustainable Construction CPD: Post occupancy evaluation.* Gaia Group. UK.

[25] Cooper, I., 2001, "Post-occupancy evaluation – where are you?" *Building Research and Information*, Vol. 29, No. 2, special issues: Post Occupancy Evaluation, pp. 158 – 163.

[26] Bordass, B., et al., 2001, "Assessing building performance in use 5: conclusions and implications", *Building Research and Information*, Vol 29, No 2, pp. 144-157.

[27] Andreu, I., Oreszczyn, T., 2004, "Architects need environmental feedback", *Building Research and information*, Vol 32, No 4, pp. 313-328.

[28] Preiser, W. F. E., Vischer, J. C., 2005, *Assessing Building Performance*. Elsevier. Butterworth Heinemann.

[29] RIBA 1991

[30] Preiser, W.F.E. (1995), ``Post-occupancy evaluation: how to make buildings work better", *Facilities*, Vol. 11, pp. 19-28

[31] Bunn, R, 2009, "Sustainable Schools: Defining the Issues", RIBA, 66 Portland Place, London W1B 1AD, Friday 11 December 2009

[32] Department for Children Schools and Families (DCSF), 2009, 2.

[33] DCSF, 2009

[34] DCSF, 2009, 4.

[35] DCSF, 2009, 8.

[36] Stevenson, F. 2010. In the special issue *Building Research & Information* 38 (5), 435 - 436

[37] Stevenson, F. 2010, 436

[38] Vale, B and Vale, R. 2010. Domestic energy use, lifestyles and POE: past lessons for current problems, *Building Research & Information*, 38: 5, 578 — 588

[39] Leaman, A , Stevenson, F. and Bordass, B. 2010 Building evaluation: practice and principles, *Building Research & Information*, 38: 5, 564 — 57

[40] Gaia Research, 2003, *Sustainable Construction CPD Module 12: Post occupancy evaluation*. Gaia Group.

[41] Preiser, W., 2002, *Learning from our Buildings: A State of the Practice Summary of Post Occupancy Evaluation,* National Academy Press, Washington, DC, available at: www.books.nap.edu/books/0309076110/html/R1.html (accessed January 2004); Leaman, A., 2003, "Post occupancy evaluation", paper presented at *Gaia Research Sustainable Construction Continuing Professional Development Seminars.*

[42] Higher Education Funding Council for Europe (HEFCE), Association of University Directors of Estates (AUDE) and University of Westminster (2006), "Guide to Post-Occupancy Evaluation", London. www.aude.ac.uk/uploads/POE%20Brochure%20Final%2006.pdf.

[43] Whyte, J. and Gann, D.M. (2001), *"Closing the loop between design and use: post-occupancy evaluation",* Building Research and Information, Vol. 29 No. 6, pp. 460-2

[44] Preiser, W. (1995) *'Post-occupancy evaluation: how to make buildings work better'. Facilities*, Vol. 13. No. 11, pp. 19-28.

[45] Guy, S., Farmer, G., 2001, "Reinterpreting Sustainable Architecture: The Place of Technology", *Journal of Architectural Education*, pp. 140-148.

[46] Sara Cook, S.J., Golton, B.L., 2004,"Sustainable Development: Concepts and Practice in the Built Environment", *Sustainable Construction CIB TG* Vol 16, pp. 677-685.

[47] Guy, Simon and Graham Farmer, 2001

[48] Ibid.,

[49] Egan, J. (1998), *Rethinking Construction*, HMSO, London

[50] Sanoff, H. 2001, "School Building Assessment Methods", NCEF, Washington, D.C. edfacilities.org/pubs/sanoffassess.pdf, 3

[51] Sanoff, H., 2000, Community Participation Methods in Design and Planning. Wiley; Sanoff, H. (2001), "School Building Assessment Methods", NCEF, Washington, D.C. edfacilities.org/pubs/sanoffassess.pdf

[52] Sergiovanni, T., 1994 *Building Community in Schools*, San Francisco. Jossey Bass.

[53] Wheeler, A. 2009 "The Ethical Dilemma of Lifestyle Change: Designing for sustainable schools and sustainable citizenship". *Les ateliers de l'éthique*, 4(1), 140-155.

[54] See Defra commissioned research which include projects EV0515: Testing innovative approaches for achieving pro-environmental behaviours – Schools as Networks; and EV0514: Testing innovative approaches for achieving pro-environmental behaviours – Maiden Lane Gardens. Online: http://randd.defra.gov.uk

[55] Cahill, C., 2006, "Defying Gravity? Raising Consciousness Through Collective Research", *Children's Geographies*, Vol 2, No 2, pp. 273–286.

[56] Torre, M. E *et al* 2001 "A space for co-constructing counter stories under surveillance" *International Journal of Critical Psychology*, 4, 149 – 166; Pain, R. 2003 "Social geography: on action-orientated research" *Progress in Human Geography*, 27 (5), 677-685; Pain, R. and Francis, P. 2003 "Reflections on participatory research" *Area*, 35, 1, 46-54; Ruddick, S., 2004 "Activist geographies: building possible world", in P. Cloke, P. Crang and M. Goodwin, eds., *Envisioning human geographies*, London, Arnold, 229 - 246

[57] Bordass, W., 2009. *Passivhaus schools: The route to low-energy schools in the UK?* [Lecture] RIBA, London, 11 December. Presentation slides available online at: < http://www.usablebuildings.co.uk/Pages/UBEvents.html> [Accessed 14 November]

[58] Bunn, R., 2009. *Sustainable Schools: Defining the Issues*, [Lecture] RIBA, London , 11 December. Available online at: < http://www.usablebuildings.co.uk/Pages/UBEvents.html > [Accessed 14 November 2010], 21

[59] Newman, M., Woodcock, A. and Dunham, P. 2009. "Results from a Post-Occupancy Evaluation of Five Primary Schools" in *Contemporary Ergonomics*, edited by P.D. Bust, ed. Taylor Francis edn. London, 462-470; Chernley, F., & Flemming, P., 2010. "Engaging Pupils in the Design of Low Energy Building". CIBSE, 15

[60] Gill, Z.M., Tierney, M.J., Pegg, I.M. and Allan, N. 2010. Low-energy dwellings: the contribution of behaviours to actual performance. *Building Research and Information*, 38(5), 491-508; Gram-Hansen, K. 2010. Residential heat comfort practices: Understanding users. *Building Research and Information*, 38(20), 175-186; Stevenson, F. 2008. *Post-occupancy evaluation of housing* [Online]. Power Point presentation available at: *www.usablebuildings.co.uk/Pages/UBEvents.html* [accessed: 14 November 2010].

[61] Sanoff, H. 2001, "School Building Assessment Methods", NCEF, Washington, D.C. edfacilities.org/pubs/sanoffassess.pdf;

[62] Sanoff, H. 2001, 19.

[63] Sanoff, H. 2001, 21; Hart, R. 1997. *Children's Participation: The Theory and Practice of Involving Young Citizens in Community Development and Environmental Care*. New York: UNICEF and London: Earthscan.

[64] Frances, M. 1998, "Negotiating Between Children and Adult Design Values." *Design Studies* 9, 2: 67-75

[65] Stevenson, F. 2008. *Post-occupancy evaluation of housing* [Online]. Power Point presentation available at: *www.usablebuildings.co.uk/Pages/UBEvents.html* [accessed: 14 November 2010].

[66] Vogel, S. 2009 "Focus groups with Children" In Fielder, J. & Posch, C. (eds.), *Yes they can! Children Researching their Lives.* Germany, Verlag.

[67] Hall, C, Jones, K, & Thomson, P, 2011. "Snapshots, illustrations and portraits: re-presenting research findings". In: Thomson, P. & Sefton-Green, J. (eds.) *Researching Creative Learning: Methods and issues*. London, Routledge.

[68] Watson, C. & Thomson, K., 2005. "Bringing Post-Occupancy Evaluation to Schools in Scotland". *Evaluating Quality in Educational Facilities.* OECD Available online at: http://www.oecd.org

[69] Friedman, A., Zimring, C., and Zube, E. 1978. *Environmental design evaluation.* New York: Plenum Press.

[70] Biesta 2009; Cahill, C 2007 "The personal is political: Developing new subjectivities through participatory action research" *Gender, Place & Culture*, 14 (3). See also: Fitzgerald, R. Et al 2009 "Children's participation as a struggle over recognition: exploring the promise of dialogue", in *A Handbook of Children's Participation: Perspectives from Theory and Practice*, edited by B. Percy-Smith and N. Thomas. Abingdon: Routledge, 330 -342; and, Mannion, G. 2009. After participation: the socio-spatial performance of intergenerational becoming, in *A Handbook of Children's Participation: Perspectives from Theory and Practice*, edited by B. Percy-Smith and N. Thomas. Abingdon: Routledge, 330 -342; Scott, W 2010 "New Worlds Rising? The View from the Sustainable School" *Policy Futures in Education*, 8 (50), 597 – 599

[71] Taskforce on Sustainable Lifestyles. 2010. *Sustainable Lifestyles Innovation Brief.* United Nations Environmental Programme. Available: http://www.unep.fr/scp/marrakech/taskforces/downloads/home/english/SLT%20Innovations%20Brief.pdf [accessed: 14 November 2010]