Designing Intelligent Schools

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Abstract

Buildings can enhance teaching and learning by high quality design and management. The physical environment affects the not only the body but the mind in terms of concentration. Unfortunately the environment in many schools is tiring for pupils and teachers. This paper will discuss the design and management processes and proposes a series of actions which can increase the likelihood of attaining school architecture which is fresh and pleasant for pupils and teachers. Barriers exist between consultants and contractors. The traditional janitor caretaker is now the site manager but has this ensured that the facilities management really takes place in practice? There is a demand to lower energy consumption but this cannot be done at the expense of quality environments for the learning process to take place in. Evidence based research and practice is used to give recommendations for designing and managing intelligent schools which are responsive to user needs.

Keywords: procurement, design quality, user needs, management process
1. Introduction

In the UK, the Building Schools for the Future (BSF) programme represents the biggest single government investment in improving school buildings for over 50 years. The stated target is to achieve educational buildings that inspire new ways of learning and to provide ‘excellent’ facilities that benefit the whole community. This is to be achieved by rebuilding or refurbishing every secondary school in England over a period of 10-15 years (DfES 2004b). The initiative comes on the back of an increasingly widely held belief that older schools, as well as those more recently built or refurbished, are inadequate in their ability to cope with anticipated changes such as shifting pedagogy, curriculum and learning expectations (Audit Commission 2003). There is, as such, a clear recognition that the public sector must be provided with environments that provide children with good places to learn and that schools should be designed to the highest quality (e.g. HM Government 2006). In this context the term ‘design quality’ has been given great prominence (CABE, 2003; DfES, 2004b; HM Government, 2006; CABE, 2006; OGC, 2007). The aims of the BSF programme are to:

- improve learning and achievement for every child and young person;
- use new thinking and opportunities and be creative in designing for learning;
- enhance school diversity and parental choice;
- increase the use of schools by the community;
- seize opportunities through new technologies; and
- produce places for learning that are exciting, flexible, healthy, safe, secure and environmentally sustainable

2. Establishing the principles of design quality

Cardellino et al (2009) has established a set of core tenets of design quality that can be categorised into: functionality and fitness for purpose, efficiency and sustainability, build quality, flexibility and adaptability, aesthetically pleasing, contextual fit, inspirational, accessibility, and safe and secure environments.

*Functionality and fitness for purpose*

A functional school building is one that through its design addresses present and future changes in pedagogy (e.g. DfES, 2002; Building Futures, 2004, OECD, 2004). That the building is ‘fit for purpose’ is viewed as a crucial component of design quality and vital to the achievement of a good school building.
**Flexibility and adaptability**

Past approaches to school design are deemed to have hindered the ability of adapting the building to future needs in education (Building Futures, 2004). Designing flexible environments is believed to enable the adoption and adaption of the emerging changes in education (e.g. DfES, 2004). Thus, flexible and adaptable building designs ‘future proof’ the spaces and allow for a variety of uses at different points in time (CABE, 2006). Furthermore, it is suggested that flexible or ‘agile’ designs will allow for short-term changes of layout and use, and for long-term expansion or contraction (Building Futures, 2004). However, the need to strike a balance between flexibility, specificity and the functional aspects of the school (teaching areas) and social spaces are also explicitly expressed (Building Futures, 2004; CABE, 2006).

**Inspirational, safe and secure**

Inspirational school buildings are supportive of effective teaching and learning and inspire users to learn (DfES, 2004c; OECD, 2004; CABE, 2005; CABE, 2007). The ultimate aim is for spaces that foster creativity, delight and a culture of learning. The design of learning environments that have something unique about them will make these spaces special - ‘spaces’ that become ‘places’ (CABE, 2006). This can be achieved through the design of environments that accommodate a wide range of experiences and activities and that include all types of learning: intellectual, physical, practical, social, emotional, spiritual and cultural (Building Futures, 2004). Inspirational buildings support a diversity of learners and inspire not only the pupils, but also those who work and visit the school.

**Aesthetically pleasing and contextual fit**

A building is considered to be ‘beautiful’ when it ‘lifts the spirits’ of those who come into contact with it (CABE, 2007). An aesthetically pleasing building is portrayed as not only having the potential to create a ‘sense of place’ in the internal school environment, but also as having a positive effect on the local community (HM Government, 2006). Likewise, a school that is welcoming and accessible is portrayed as having a positive impact not only on the users of the building, but also on the surrounding areas (DfES, 2002; CABE, 2006).

**Build quality and sustainability**

Well designed learning environments should provide a platform for wider learning agendas ranging from the issues of citizenship to sustainability. CABE (2006) presents the sustainable character of the building, in terms of the use of natural light and ventilation, the consideration of alternative forms of energy and the choice of robust materials from sustainable sources, as a means to highlight and disseminate environmental issues.
3. Design quality in practice

In a recent PhD study undertaken by Zulkiflee Abdul Samad at the University of Cambridge (Intangibles in the Building Environment, Explored through UK Primary Schools, 2008) 20 case studies were undertaken of new primary schools in England completed between 2001 and 2004. Five key stakeholders were interviewed at each school – the Local Authority Education Officer (representing the legal client) the headteacher and the chair of the governors (representing the user client), and the architect and quantity surveyor (representing the design team).

The study focused on the respondents’ perceptions of the contribution of the school premises (the building) to social outcomes. These outcomes are frequently quite difficult to measure, or intangible, and include items such as pupil attainment, pupil happiness, pupil attendance and truancy, staff recruitment and retention, staff morale, supervision of pupils, school image, community involvement, flexibility and adaptability of the building interior for different educational styles, safety and security, and the potential of the school building as a teaching tool.

The interview questions covered issues such as whether:

• the key criteria for the school had included any or all of these social outcomes

• these had been cited in the briefing to the design team and/or in project documents

• there had been discussion of any or all of them during meetings between client and designer during the design process

• respondents agreed that good design can bring intangible educational benefits

• making requirements about these intangibles explicit helps to elicit higher standards of design from design teams

• better valuation methods for intangibles encourage capital investment to ensure they are delivered. And they were asked whether they had attempted to place a value on these outcomes so as to ensure sufficient costs were provided in the school construction budget to ensure their delivery in practice.

Interviewees were also asked about pupil attainment and educational outcomes, and how they viewed the achievement of social outcomes in the school; as well as whether they believed the school design was important in influencing outcomes.

Of the 20 case studies, ten schools were selected for detailed analysis – specifically those where the users (head-teacher, governor) had high perceptions of the potential benefits from good design, and those where perceptions were lowest. The opposite extremes of the spectrum provided dramatic differences in stakeholder perceptions.
Among the **high-perception** cases, where the users believed in the potential of good design, they had typically been fully involved in the design process and made demands on the designers to ensure their knowledge and understanding were implemented. An architect in a high perception case said about whether the building has an impact on educational outcomes:

> “Of course it can. Because the quality of schools design has an effect on the well-being of children, they way they think, their behaviour, teaching, staff satisfaction ...If your teachers and pupils look forward to going to school every day and love being in the building, you’ve a lot because they are going to teach and learn properly. ... I received a very good briefing document from the Council, containing requirements and aspirations that cover these outcomes with clarity.”

A school governor said:

> “Quality of school design has an effect on the well-being of children, they way they think, their behaviour, teaching and staff satisfaction. I think if you create an environment in which pupils are stimulated, they are content. ... a comfortable environment, which is spacious and not cramped, then I think that can inspire them.’

An independent assessment of this particular school reported:

> “Everyone who visits the school is stunned by the quality of environment, and all of us who work here particularly like the ambience. We really enjoy working in the new school. The building provides and excellent and delightful teaching environment for pupils and staff.”

Among the **low perception** cases the replies included comments such as:

> “Designers have no knowledge of what sort of design supports teaching and learning. We don’t have the opportunity to debate about the impact of the physical environment on teaching and learning. Unless we share that with the architect, they would not be able to respond through their design. An architect wouldn’t know the real demand of school building.” (Head teacher)

> “The building is just a tiny part of the school. Design is just one small part of the whole education process. It gives very little contribution to education. It is not fair to make architects responsible for examination results and children’s achievements.” (Architect)

In another case, stakeholders said:

> “It’s just a building. It just gives a space for children and teachers to work in.” (Head teacher)

> “I wouldn’t spend more time and money on the building because it wouldn’t be the most important thing for the children’s education.” (Governor)
Here value engineering exercises resulted in smaller classrooms, a smaller staff room and the omission of two WCs.

Other low perception cases revealed similar perceptions, that personalities were much more important than the premises, that the school is just a building, that educational outcomes were not driving factors, and that construction costs determined the school.

Comparing the high perception cases with the low perception ones, it became apparent than the high perception cases were characterised by:

- High stakeholder involvement in the briefing and design process
- High demands by clients with outcomes emphasised to the design team and explicitly conveyed to them
- Design checked periodically by clients using their experience to assess potential impact on outcomes
- In some cases, extra funds raised where educational outcomes appeared to be at risk from cost constraints.

As a result of these actions, the resulting designs were considered successful by stakeholders, and independent reports by the school inspectorate OFSTED commended four out of the five high perception cases.

In considerable contrast, among the low perception cases, there was low involvement of users in the design process, low or very low awareness of the potential impact of the building on outcomes, and examples where value engineering exercises has been allowed to reduce the quality of the completed school under the guise of costs savings. Most telling were the views – and disappointments – among the low perception cases, of users in response to the completed buildings. They found inadequacies in the designs, and these were also noted by the school inspectorate, OFSTED. It was ironic to discover that those who denied that the premises had any impact on outcomes typically ended up being least satisfied with the school building they were given.

Many conclusions arise from the study. **The most crucial one is that where stakeholders (clients, users and designers) have a low perception of the connection between good design and educational attainment, poorly designed buildings are the likely outcome.** Unless and until stakeholders’ perceptions are raised, the UK building programme is likely to produce a large number of schools – perhaps a quarter of the total number on the evidence reported here – that are not well-designed and disappoint their users.

The Cambridge study shows that several attributes of design quality are of a subjective nature and will be given varying importance by different stakeholders in the BSF programme. All the various stakeholders, e.g. consultants, contractors, site managers representatives of government bodies,
teachers (and pupils) and education officers, have a significant impact on design quality. Reading study has also explored these stakeholders’ perceptions about the important attributes of good design are and how effective these work in practice. The survey responses are described in Cardellino et al (2009).

**Fitness for purpose and educational transformation**

*I think we are aware that actually we are designing schools that are 20th century schools rather than 21st century schools in the sense of they are still largely departmentally organised and so on, rather than organised in a freer form that a personalised learning might determine. [DfES representative]*

Thus, there is a belief that the introduction and implementation of these educational approaches to various degrees are dependent on the design of school buildings. Yet, there is real concern regarding the ability of those involved in the design process to address the rapidly changing pedagogies.

Of particular concern and frequently mentioned was the difficulty in achieving educational facilities that not only are functional now but that will also in the future.

Contractors and architects were aware that changes in education will have an impact on the building design but they were in doubt about the extent to which the building would impact on the attainment of educational goals. The building was portrayed as but one component of the school environment.

The common conclusion was that **fitness for purpose can only be achieved through more participation of the teachers in the process and the provision of sufficient funds to educate users on how to use the building.**

**Flexibility and adaptability**

Within the BSF the design of flexible learning environments is considered crucial in enabling the implementation and adoption of different approaches to education. The ‘every child matters’ agenda is founded on an acceptance that each pupil is an individual and therefore will learn in different ways. This requires the design of flexible spaces:

Designing flexible buildings was interpreted as introducing a variety of alternative spaces. However, in their accounts the interviewees kept returning to the difficulties of **conceptualising and accommodating potential unpredicted changes.**

Amongst the architects this issue was addressed primarily by arguing for the need to include in the school building a combination of different spaces that can be easily adapted to address the individuality of the pupils. Flexible spaces are those that can be easily transformed to accommodate the day-to-day changes in pedagogy. Long-term changes are addressed by the adaptability of the design.
The character of the building

The idea that the building should be aesthetically pleasing was prevalent amongst the architects. Some interviewees were less enthusiastic about this aspect of design quality and concerns were raised regarding the benefits of designing so-called ‘fancy’ buildings. The contractors and some consultants considered these benefits to cost too much and have minimal, if any, impact on learning.

Creating a ‘sense of place’ within the school environment was acknowledged as an important aspect of design quality. Architects are committed to creating designs that encourage social interaction between pupils and staff. Their descriptions of how this was to be achieved within the school building tended to be quite emotive and used analogies such as ‘special spaces’ and the ‘heart of the school’.

4. Conclusions

The Reading and Cambridge research studies show that the guidelines provided in BB98 are all too often seen to constitute the minimum accepted standards for a school facility that in their opinion all too often were used as criteria for assessing costs. In contrast, there are contractors and consultants who rather pragmatically believe in the importance of prioritising the aspects that are most important to the individual school. However their priorities regarding contextual fit and their views on the potential impact of the school on the individual and the wider community differed from the architects. They also considered the money allocated to building a school facility is not enough.

Numerous attributes of design quality were considered to be quite subjective and were given varying importance by different stakeholders. This was particularly apparent for attributes such as aesthetically pleasing and contextual fit. Different views and expectations concerning the school environment clearly exist. Omnipresent was the expressed need to view the design quality of a school as incorporating more than just the building. But so too was the difficulty of giving sufficient allowance to the commercial context in any judgement of quality of the design. Thus, it is not surprising that the practitioners frequently emphasised the challenges they face in attempting to operationalise notions of design quality. Whilst there is common acceptance of the complexity of designing a school, agreement regarding the importance of the different components of the school system and how to prioritise between them is still to be achieved. The multiple purposes of educational facilities and the conflicting views of design quality combine to make finding a balance between ‘fitness for purpose’, ‘cost effectiveness’ and ‘buildability’ of the facility a very difficult task indeed. Ultimately, the BSF programme presents an unprecedented opportunity for institutional change.

However a research study by University College London showed that many new BSF schools are failing to achieve the expected targets related to both energy consumption and indoor air quality.
This evidence was supported by a BSRIA commentary in May 2009 concerning Energy Performance Certificates in which it was stated that by the end of 2008 only 43 out of 92 schools had performed in bands A-C (www.bsria.co.uk/news/epc-schools).

a. post-occupancy performance of five low energy schools in the UK has showed that four of the schools evaluated had higher carbon emissions than the median UK school building (Pegg, et al, 2005) (Pegg, et al, 2008). It was found that the increase in the use of IT, as well as more stringent internal air quality standards, is responsible for the high energy consumption. The less obvious reasons include inadequate training to operate building management systems and failure to understand the effect of occupant behaviour on energy use in schools. Note that all five school buildings were completed in the period from 2001 to 2005, and were characterised by comparable gross floor areas and similar design criteria. This study advocates the continuing use of post occupancy evaluation to ensure that a rapid feedback loops enable designers to understand better the real design requirements for school buildings.

b. a number of newly built BSF schools with different ventilation strategies has been monitored thoroughly across a range of environmental conditions and this has revealed a number of conclusions regarding school design and build quality (Mumovic et al, 2007a); (Mumovic et al, 2007b); (Mumovic et al, 2009a); (Mumovic et al, 2009b). The studies showed that complex interaction between thermal comfort, ventilation and acoustics when providing good classroom design presents considerable problems for designers. Overall, it would seem that the basic requirement of 1500 ppm of carbon dioxide is achieved as a consequence of the window areas being just sufficient to provide the required level of fresh air with low and intermittent occupancies. To meet the higher supply rate of 8 l/s per person the window installations frequently provide inadequate openable area. Furthermore, it has been concluded that the ventilation provision may be inadequate to remove excess heat without causing discomfort from draughts. Note that all studied schools were built between 2004 and 2006 and were in compliance with the Building Bulletin 93 that significantly revised the standard for acoustic performance.

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Other studies by Bako-Biro et al (2007, 2008) show that CO2 affects pupils concentration levels and the need for fresh air is just as important as temperature requirements.

The BSF programme now has a Minimum Design Standard. The procurement period is now 75 weeks. CABE assessors make a review of initial design bids in weeks 23—30 and further reviews until the end of the procurement period (Bunn in Delta T issued by BSRIA July 2009 pages 14-15). This gives time for the design to evolve and hopefully ensures enough thinking time.
The review is based on 10 quality criteria. The assessors can include designer architects and engineers; local authority professionals; members of partnership for schools; and educationalists. It is not clear that this will solve the problems which can occur at the later stages of construction, commissioning and facilities management. We have to ensure that all the team of clients, consultants, contractors and others all have the same mission and values if we want to attain the aspirations described in this paper.

**Acknowledgements**

Part of this work was financed by EPSRC. Paulina Cardellino, Roine Leiringer and others have also researched the Reading University findings in this paper.

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