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A comprehensive review of environmental design in UK schools: History, conflicts and solutions

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ABSTRACT

The health and performance of students and teachers are influenced by the internal environment of school buildings such as noise levels, indoor temperature, air quality and light. Providing good internal environmental conditions with minimum energy for schools has long been a concern in school design guidelines around the world. The growing necessity to save energy in an uncertain future and to provide a good indoor environment in schools suggests that school designers should approach design more holistically in order to offer a better internal environment and to reduce the gap between design and performance. This paper investigates design issues in UK schools through case study analysis and a review of the literature. The main reasons for these design issues can be attributed to the lack of optimisation of different internal environment factors and their relation with energy consumption; the lack of understanding occupants' response to the environment; the lack of building adaptability and the inappropriate application or use technology. This paper urges school designers to look at these factors holistically in order to overcome these problems in the future design of UK schools. This study also suggests an Environmental Circle to look at the interrelation between comfort factors through their sub factors in a holistic manner in order to prevent any conflict between.

Contents

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1. Introduction

The process of delivering development, whether at an individual building or an urban scale, is likely to be both beset with tensions and characterised by the need to compromise on the attainment of particular performance goals. This is particularly true were such development is expected to deliver against a sustainability agenda [1]. School buildings perhaps exemplify the potential for conflict between social, economic and environmental objectives where the requirement is to deliver cost effective, energy efficient and low carbon spaces that provide the comfort conditions necessary for learning to take place [2,3]. Given that the performance of children within a learning environment is directly affected by the prevailing comfort conditions [4–8] the nature and consequences of such conflicts on the ability to achieve the desired indoor environment need to be understood fully.

In the UK, current design guidance for school buildings highlights specific requirements for issues such as lighting, ventilation and acoustic performance [9–11]. In delivering such requirements the guidance stresses the need to consider the implications of choices pertaining to one issue on the performance of others and hence on the resulting comfort conditions. For example, guidance highlights that in delivering the required level of ventilation, due consideration must be paid to ensuring acoustic performance needs are also met. Similarly they identify that the need to provide thermally comfortable spaces with appropriate air quality while consuming a minimum of energy is also likely to be a delicate balance [11,12]. This guidance also recognises that the significance of the broader economic and environmental contexts, in particular the need to deliver effective learning environments at a minimum financial and carbon cost, must form part of the decision making process [9].

Clearly, such issues require careful consideration at the design stage however that is unlikely to be sufficient to ensure the required level of performance is delivered when a given building is in use. Research suggests there is often a considerable gap between design intent and in-use performance in buildings [13–16] and that occupant behaviour is considered to be one of the likely causes of such a gap [17,18]. In schools, this gap not only threatens the efficacy of a space as a learning environment but also its financial viability and the likelihood of delivering against environmental targets. Consequently, the potential for users to exacerbate the impacts of any likely conflicts also needs to inform the design process; a key part of which must be a reflection on the implications of the practices and expectations of the variety of users that occupy school buildings.

It is important to recognise that these issues are likely to be as pertinent to the refurbishment of existing buildings as they are to new build. In addition, as the overarching philosophical approach to school design has changed over the decades [19], the relative sensitivity of schools from different era to a range of diverse conflicts is likely to vary. Consequently, refurbishment strategies need to reflect such sensitivities.

The varied school stock in the UK offers an excellent opportunity to explore these issues across a range of school archetypes. Reviewing design issues in school classrooms helps the designer achieve a high quality and energy efficient internal environment for the future generation of schools.

This paper undertakes such analysis and provides the basis for the development of a decision support tool that can help ensure designers account for the likely impacts of conflicts between environmental parameters in a way that reflect the perceptions and behaviours of users.

2. Construction age design issues in UK school buildings

The history of UK school construction is divided into four main time periods: Victorian/Edwardian, open air, post-war and post-oil crisis. Indeed, many schools constructed across all of the periods are still in use [22]. This section reviews the design issues in school classrooms built during these periods.

2.1. Design issues in Victorian/Edwardian schools

This period mainly refers to schools built from 1837 to 1901. Victorian schools fall into two distinct generations: schools which were built before and after the 1870 Education Act. This act made local authorities responsible for providing school education and the buildings in which it should occur [20]. Many of the second generation of Victorian schools are still in use [22] (Figs. 1 and 2). The major influence on the design of schools throughout England was the work of E.R. Robson, the architect surveyor appointed by the

Fig. 1. Typical three stories Victorian school (photographed by A. Montazami).

Fig. 2. Typical single storey Victorian school (photographed by A. Montazami).